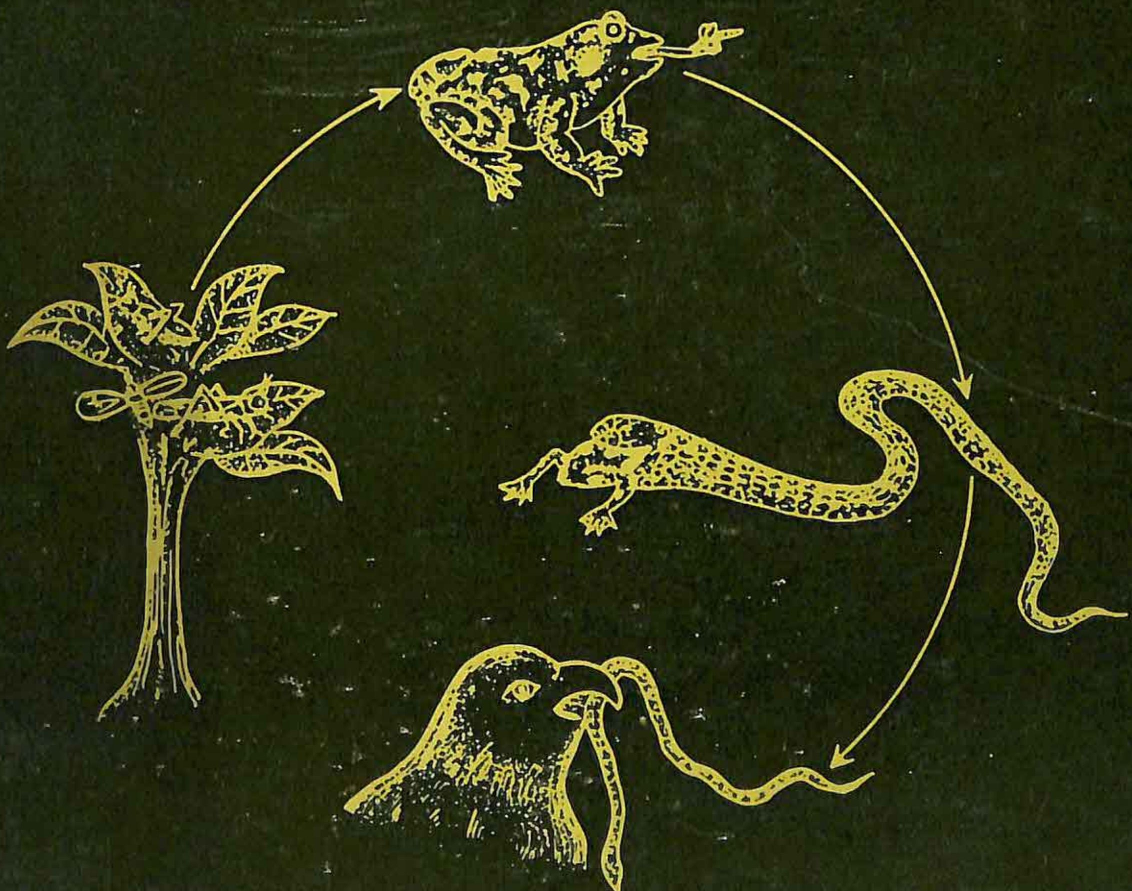
Middle School Science

BIOLOGY

Classes 7 & 8

R. Sishta • B.G. Pitre



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R Sishta
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New Delhi

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Preface

While writing this book our priorities were to present, in an interesting but simple way, the *relevant* concepts of Biology, arranged in a proper sequence to make the study of the subject interesting and systematic.

The stress on the word 'relevant' is relevant! There is a general tendency among authors to put in much more material in their books than the child can assimilate at this level. The resulting strain on the child kills his interest in the subject and his study of the subject then becomes totally examination oriented. This is the pitfall we have tried very hard to avoid. Perhaps the maximum time in producing this book has gone into planning the topics and the depth to which each should be presented. The teachers and students who use this book will of course be the best judge in ascertaining how far we have succeeded in our aim. We would welcome criticism of the book from them.

We would like to stress, however, that any scheme of study in Biology is incomplete without field work and experimentation. And the teacher's role in planning it according to the resources at hand is paramount.

Each chapter in the book has 2-4 pages of workbook portion at the end, which mainly carries simple short answer questions and provides space for the children to write the answers. We feel that this will help the children test their understanding and to recapitulate the important concepts in the chapter.

We very gratefully acknowledge the help and cooperation we have received from our friends, colleagues and families.

September 1984

R SISHTA
B G PITRE

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1

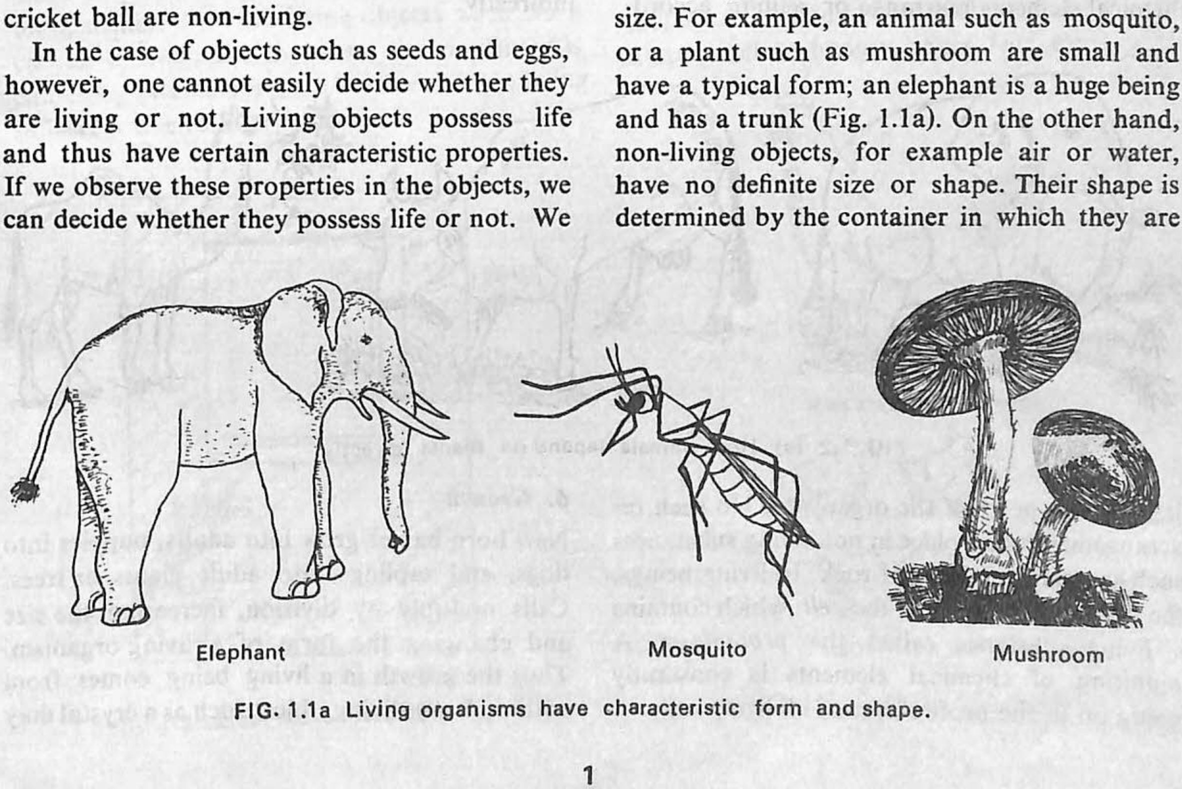
Living and Non-living

It is easy to recognise that a plant or an animal is different from a stone or a ball. All the objects around us can be divided into two main groups —the living and the non-living. A rose plant and a dog are living beings, while a stone and a cricket ball are non-living.

In the case of objects such as seeds and eggs, however, one cannot easily decide whether they are living or not. Living objects possess life and thus have certain characteristic properties. If we observe these properties in the objects, we can decide whether they possess life or not. We shall study some of these properties in this chapter.

1. Form and Size

Living organisms have a characteristic form and size. For example, an animal such as mosquito, or a plant such as mushroom are small and have a typical form; an elephant is a huge being and has a trunk (Fig. 1.1a). On the other hand, non-living objects, for example air or water, have no definite size or shape. Their shape is determined by the container in which they are



Elephant Mosquito Mushroom

FIG. 1.1a Living organisms have characteristic form and shape.

taken (Fig. 1.1b), and the size depends upon their quantity taken.

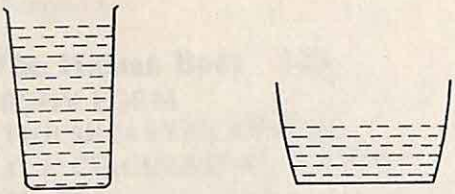


FIG. 1.1b Non-living objects do not have definite size or shape.

2. *Chemical Composition*

All living and non-living substances are composed of non-living elements such as carbon, oxygen, hydrogen, etc. In living substances, their combinations are in definite ratios. A non-living substance such as air contains these elements in no fixed ratio; water may have all types of impurities in various ratios.

3. *Cellular Structure*

In all living organisms a reorganisation of the non-living elements is constantly going on. The chemical elements rearrange or reunite according to the needs of the organisms. No such rearrangement takes place in non-living substances such as water or a piece of rock. In living beings, the basic unit of life is the *cell*, which contains a living substance called the *protoplasm*. A reuniting of chemical elements is constantly going on in the protoplasm of all living cells.

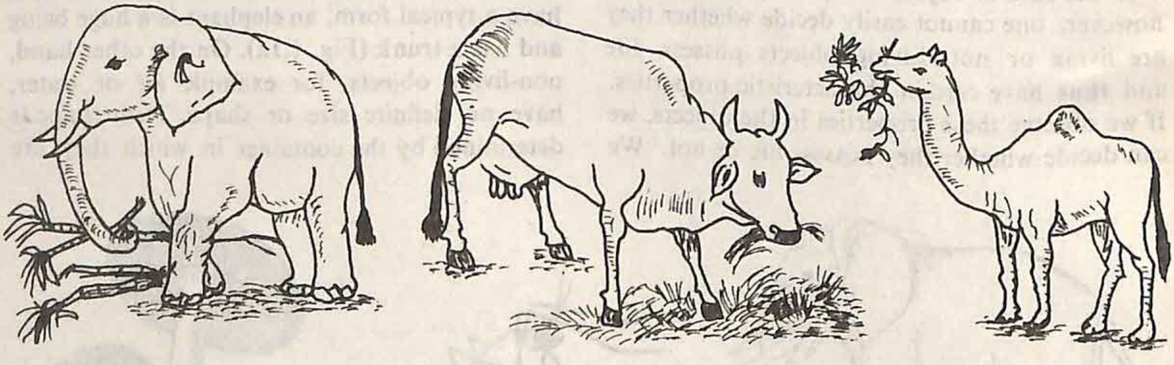


FIG. 1.2 (a) How animals depend on plants directly

4. *Metabolism*

Machines are non-living objects that require energy to do work. Living organisms also need energy for carrying on their day-to-day activities. This absorption and release of energy in living organisms takes place by certain processes known as *metabolism*. For example, during breathing the protoplasm breaks down into smaller chemical combinations of elements, and releases energy in this process. During the process of *photosynthesis*, plants take up water, carbon dioxide, etc. from the environment to form new chemical combinations of elements. During this process, the protoplasm absorbs energy. This interchange of energy, along with the chemical reactions involved, is typical of living organisms.

5. *Nutrition*

All living objects require food or nourishment while non-living objects do not. Green plants such as paddy, neem, and money plant prepare their own food with the help of sunlight and the raw materials available in the environment. Animals cannot prepare their own food. They acquire their food from the plants directly or indirectly.

6. *Growth*

New born babies grow into adults, puppies into dogs, and saplings into adult plants or trees. Cells multiply by division, increasing the size and changing the form of a living organism. Thus the growth in a living being comes from within. A non-living object such as a crystal may

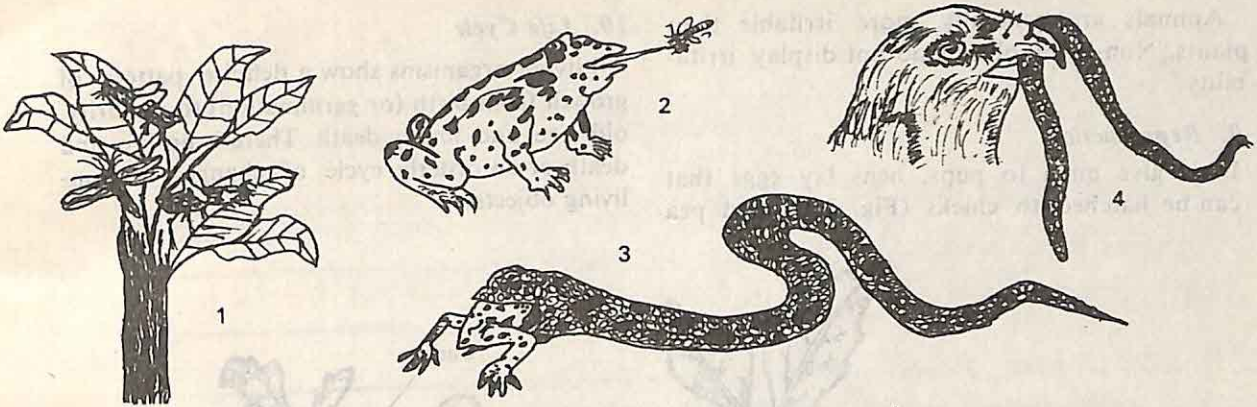


FIG. 1.2 (b) How animals depend on plants indirectly

also grow, but the increase in size is due to the addition of some materials on the outside.

7. *Movement*

Movement is one of the characteristics of all living objects, though plants do not exhibit this property as actively as animals do. The roots in plants move in the soil to absorb water and give the plant a fixed support. The leaves move towards sunlight (Fig. 1.3). Animals move from place to place for various reasons—in search of food, shelter, etc. Non-living objects such as a car or a cloud also move but the movement is caused by external forces. The movement in living objects is due to internal forces.

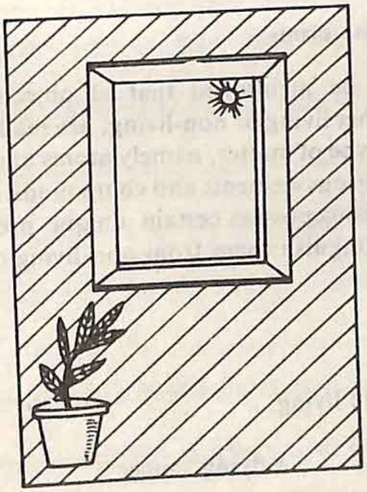
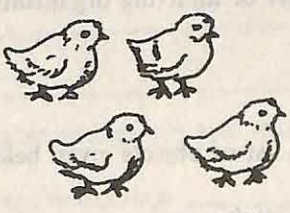


FIG. 1.3 Leaves move towards sunlight.

8. *Irritability*

Irritability is the ability to respond to some change in our environment called the *stimulus.* It is a characteristic property of all living organisms. We quickly withdraw our hand if a thorn pricks a finger. A dog barks when it is provoked. Leaves of a plant respond to the stimulus of sunlight (Fig. 1.3). These are all examples of irritability in living beings. The cause of such response is a stimulus, which is an internal or external change in the environment. The internal causes can be due to some natural feelings or instincts, such as hunger, anger, fear, etc.

Hen sitting on its eggs



Eggs hatch to chicks

FIG. 1.4 Reproduction in hen.

Animals are generally more irritable than plants. Non-living objects do not display irritability.

9. Reproduction

Dogs give birth to pups, hens lay eggs that can be hatched to chicks (Fig. 1.4), and pea seeds are sown to produce pea plants. Brinjal seeds will produce only brinjal plants (Fig. 1.5), mango plants will give only mangoes, not other fruits. Thus living objects reproduce young ones only of their own kind. Reproduction is a characteristic feature of all living organisms.

10. Life Cycle

All living organisms show a definite pattern of growth from birth (or germination) to maturity, old age and finally death. There is no life and death or an orderly cycle of changes in non-living objects.

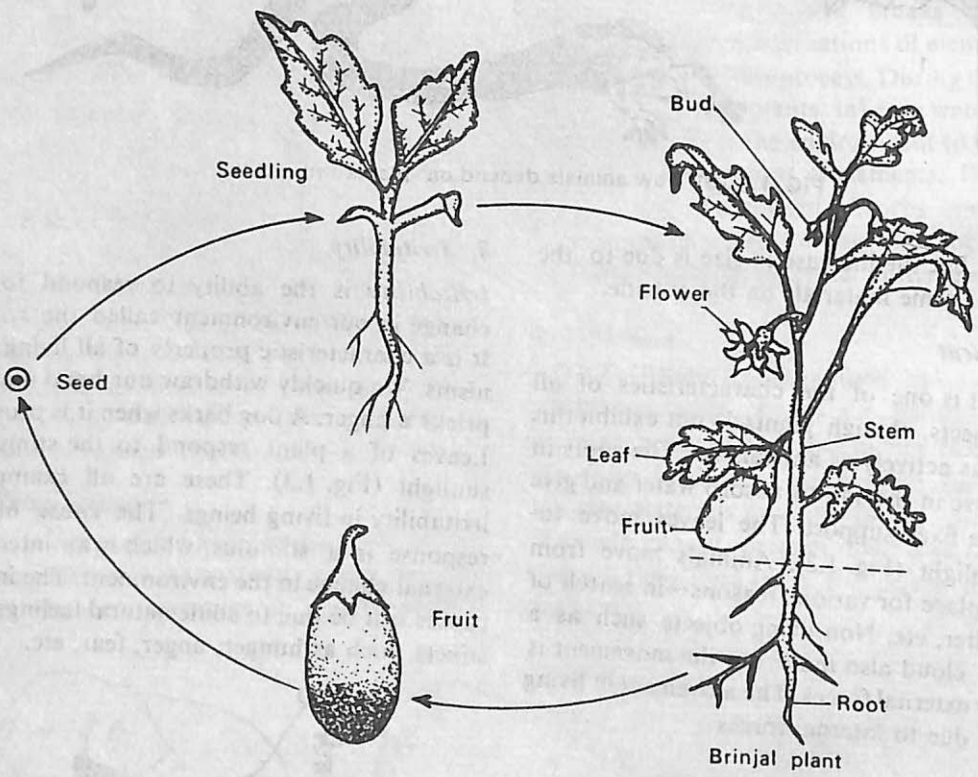


FIG. 1.5 Reproduction in brinjal plants.

It may be mentioned that all objects in the world, either living or non-living, are made up of the same type of matter, namely atoms and molecules of various elements and compounds. Yet living organisms possess certain unique properties which distinguish them from non-living objects.

EXERCISES

1. From the list of objects given below, encircle those that are living.

a walking stick

a gram seed

a cricket bat

an insect

a flying saucer

a brick

an octopus	an owl	Campa cola
a snail	an aeroplane	a sugar crystal

2. Explain how the building of a body is different from the building of a house?

3. An aeroplane and a bird fly: a car and a dog run on the road. Explain the movements stating whether they are living or non-living objects.

4. Is an 'egg' a living or a non-living object? Discuss with reasons.

5. A plant does not move from one place to another like an animal. Discuss this in reference to the characteristic properties of living objects.

6. Protoplasm is made up of non-living elements of which water and air are also made up of. Explain why the protoplasm is living while water and air are non-living.

7. In the following examples, state the characteristic property of the living being which causes the behaviour observed.

(a) You are cycling on a road when you hear a horn; you suddenly look back and take the cycle to the left. __________

(b) A friend informs you that a baby sister has been born in his family that morning. __________

(c) The newspaper reports that milk is very essential for young children. __________

8. When you sow paddy seeds in a field, do you expect wheat plants? Discuss. __________

9. Explain the following.

(a) Cell __________

(b) Protoplasm __________

(c) Metabolism __________

(d) Stimulus __________

(e) Irritability __________

2

Plants and Animals

We have seen that all living beings have certain common characteristics, such as the ability to move and respire, the need for food, the response to stimulus, the ability to reproduce their own kind, etc. There is an infinite variety of living organisms differing in form, structure and habits. Yet they can all be classified as either *plants* or *animals*.

It must be remembered that both plants and animals have in common, to a greater or lesser extent, all the characteristic features of living beings. However, there are some fundamental differences between them. These are as follows.

1. Cellular Structure

The very structure of the cells, the basic units of life, is different in plants and animals. The plant cell is enclosed in a rigid, thick non-living *cell wall.* The cell wall of the plant cell is made up of a non-living substance called *cellulose.* Animal cells have no cell wall (Fig.2.1). The cytoplasm (the portion which forms the main body of the cell) of a plant cell contains *plastids.* These may be *chloroplasts* which contain the green pigment chlorophyll for photosynthesis, or *chromoplasts* containing pigments which give colour to flowers and fruits, or the colourless *leucoplasts* which are used for storing reserve food. Animal cells do not contain plastids.

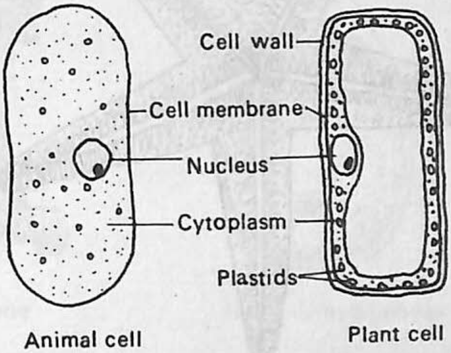
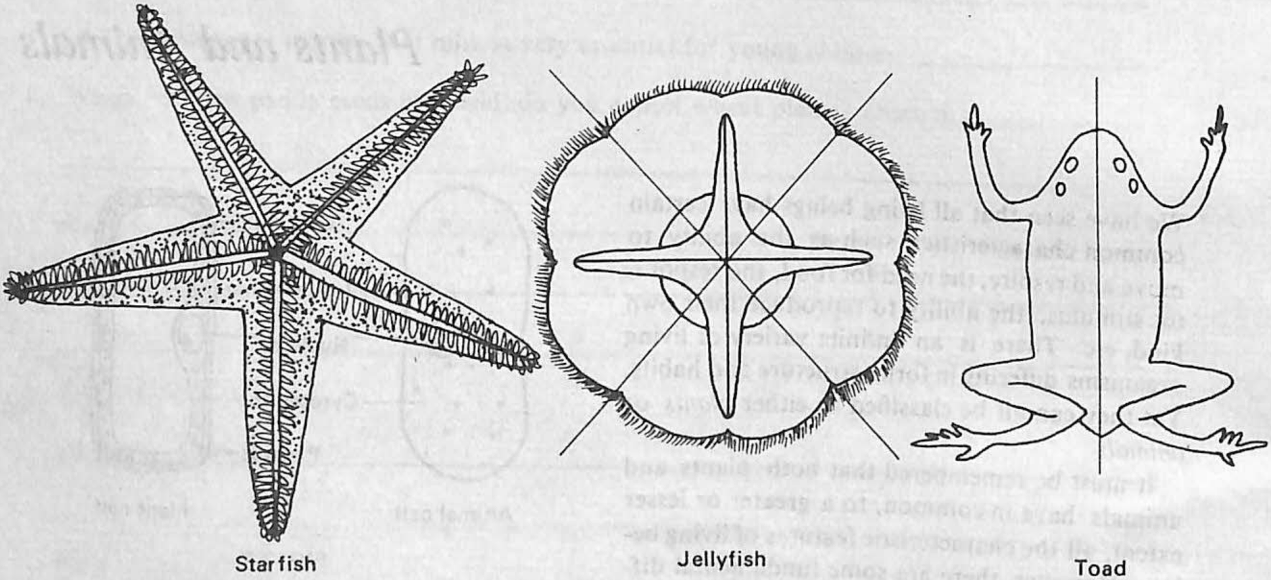


FIG. 2.1

2. Form and Structure

Observe a few mango trees in your locality. You will find that they have a typical appearance. However, a closer examination will show that no two trees are alike in their shape or form. The trees are highly branched and the branching differs considerably in any two trees. You will also notice that the trees do not have any symmetrical shape. We therefore say that plants have *asymmetrical* bodies which are highly branched. This is true not only of the stem, but of the root system as well. Now observe two frogs or cats. You will find that they resemble each other much more closely. Their bodies are more compact and symmetrical. There are no asymmetrical branches like in plants. The various organs such as eyes and ears are symmetrically arranged, and are in similar positions in the same species.

Animals such as man, cat, dog, toad, etc. have *bilateral symmetry*, i.e their organs are arranged in the body in such a way that if the animal is cut into two halves lengthwise, both the sides will have the same organs. Animals such as starfish, jellyfish (Fig. 2.2), sea-urchin, etc. are said to be *radially symmetrical*, i.e. their organs are arranged along different radii. Bilateral symmetry provides better and faster movement in animals.


Starfish

Jellyfish

Toad

FIG. 2.2 Symmetry among different animals.

3. Nutrition

Animals cannot prepare their own food. They depend on plants or other animals for their food. Their food consists of complex substances, which are reduced to simpler forms by the process of digestion. Nutrition among animals is called *heterotrophic* or *holozoic* nutrition.

Plants, in general, take in very simple substances that are composed of small molecules, namely carbon dioxide from air, and water and dissolved salts from the soil. In their leaves they combine carbon dioxide and water to form carbohydrates, using sunlight absorbed by the chlorophyll as a source of energy. From these carbohydrates, and salts taken in from the soil, green plants can make any of the substances needed for their existence. The type of nutrition in green plants is called *holophytic* or *autotrophic* nutrition. The process by which these plants prepare food in their leaves, with the help of carbon dioxide, water and sunlight is called *photosynthesis*.

Thus, nutrition in animals involves a breaking down of complex substances to simpler substances, while nutrition in plants involves synthesis of complex substances from simple substances.

4. Growth

Growth in plants is indefinite and unlimited. They continue to grow throughout their life. Their growth is mainly due to the growing zones which are present at certain fixed regions of the body such as the root tips and stem tips. The young brances of trees have growing points at the apices. If these points are removed, the branches stop growing in length.

Growth in animals is limited or definite, i.e they grow upto a certain age and stop growing after that. Moreover, they do not have fixed growing points as in plants. All the parts of the animal body grow at a uniform rate.

Plants generally grow by the addition of external parts such as leaves, flowers and branches. In animals, on the contrary, growth is mainly internal, although certain visible parts such as feathers, hair or horns also show a gradual increase in size.

5. *Movement*

Animals move actively from place to place in search of food and shelter, whereas plants are generally fixed to the soil by the roots. The movement in plants is very slow and is confined to the movement of roots towards water or that of leaves and flowers towards light. There are, however, exceptions also. Aquatic animals such as sponges, sea-anemones, etc. (Fig. 2.3a, b) cannot move, whereas the unicellular plant, chlamydomonas (Fig. 2. 3c) can move about in water.

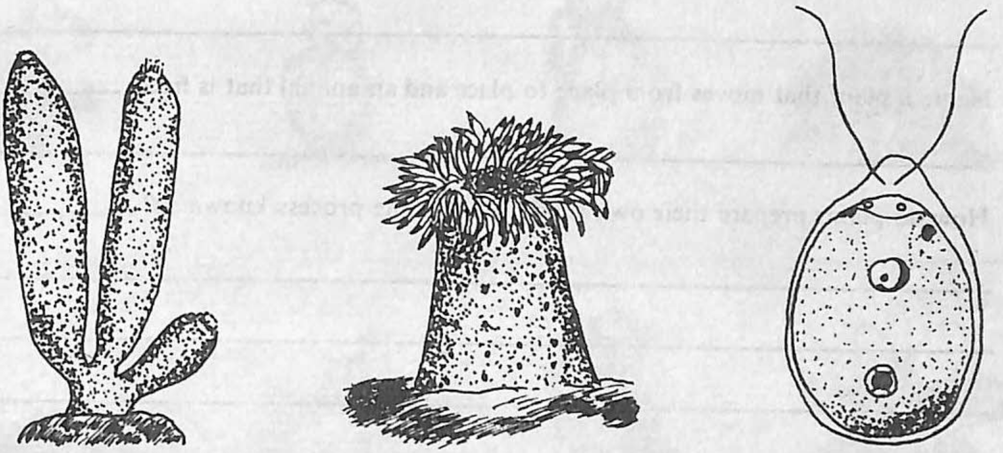

(a) Sponge (b) Sea-anemone (c) Chlamydomonas

FIG. 2.3

6. *Sensitivity*

Although both plants and animals respond to stimuli, the response of an animal usually follows almost immediately after the application of even a brief stimulus. This sensitivity among animals is because of a well developed nervous system and the possession of sense organs. Plants, on the other hand, respond very slowly to stimuli. A response may take place over a matter of hours or days and, even then, only if the stimulus persists for a relatively long period. However, few plants such as touch-me-not (mimosa) are very sensitive to touch and show immediate response by closing their leaves. Some animals such as sponges do not respond to stimuli.

EXERCISES

1. How are plants similar to animals?____

____

2. What are the dissimilarities between a plant cell and an animal cell?__________

3. In what way does bilateral symmetry help animals?

4. Name two animals that exhibit radial symmetry.

5. Why do animals move from place to place?

6. Name a plant that moves from place to place and an animal that is fixed.

7. How do plants prepare their own food? What is the process known as?

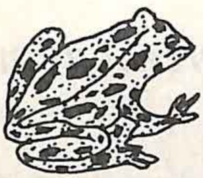
8. In what way does nutrition differ in animals and plants?

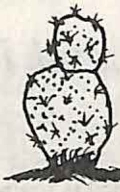
9. How do plants respond to external stimuli? What can be their stimuli?

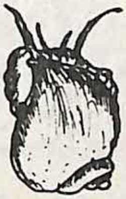
10. Why do animals respond to external stimuli very quickly?

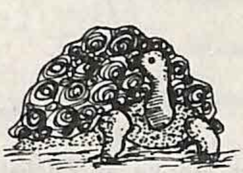
11. Explain 'growing zones' in plants. Are these present in animals also? ______

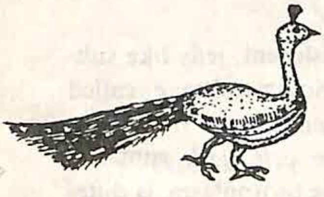
12. A picture showing different living organisms is shown in Fig. 2.4. Name the organisms and classify them as plants or animals.

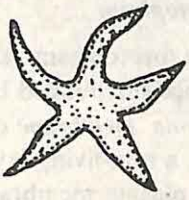


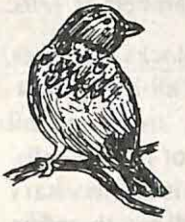


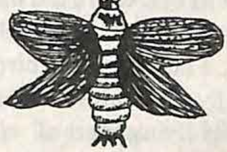


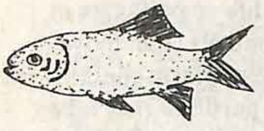


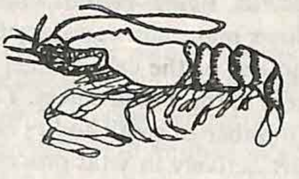


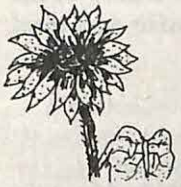


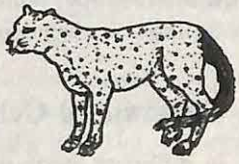












3

Cell and Its Differentiation

Robert Hooke, an English scientist of the 17th century, while observing a cork piece under the hand lens he had made, found that it was made up of small chambers covered by walls all around. He termed these small chambers as *cells.*

Just as bricks are the building blocks of houses, cells are the building blocks of all living organisms. The bodies of birds, men, trees and all other living beings are made up of minute cells. A cell is living, and all vital activities necessary for life go on within the cell. A cell can therefore be defined as *a structural and functional unit of plants and animals.* Most cells are five to fifteen thousandth of a millimetre in size. We are able to study their detailed structure because of the electron microscope, which magnifies an object 100,000 times or even more.

The Generalised Cell

Cells in different living organisms, and in different parts of the body, vary in structure. However, their basic organisation is similar. A *generalised cell* (Fig. 3.1) is one which combines the common features of all cells. It does not actually exist as such, but is useful for studying the structure and functions of a cell.

The cell is made up of a living substance called *protoplasm*, which consists of complex compounds of elements chiefly carbon, hydrogen, oxygen and nitrogen.

Protoplasm

The protoplasm is a translucent, jelly-like substance surrounded by a living membrane called *plasma membrane* or *cell membrane*. In a plant cell, a non-living layer, the *cell wall,* supports the plasma membrane. The protoplasm is differentiated into two parts, *cytoplasm* and *nucleus*.

CYTOPLASM

Cytoplasm is a jelly-like fluid occupying the space between the plasma membrane and the nucleus. Being porous, the plasma membrane allows materials necessary for life to permeate in and out of the cell. It thus controls the movement of these substances. The cytoplasm contains a number of small bodies and particles that take part actively in vital processes of the cell. Such parts of the cell are known as *cell organelles*. Besides cell organelles, cytoplasm consists of *vacuoles*, which are cavities within the cytoplasm. In plants these are large and their number is more. In animals they are small and their number is less.

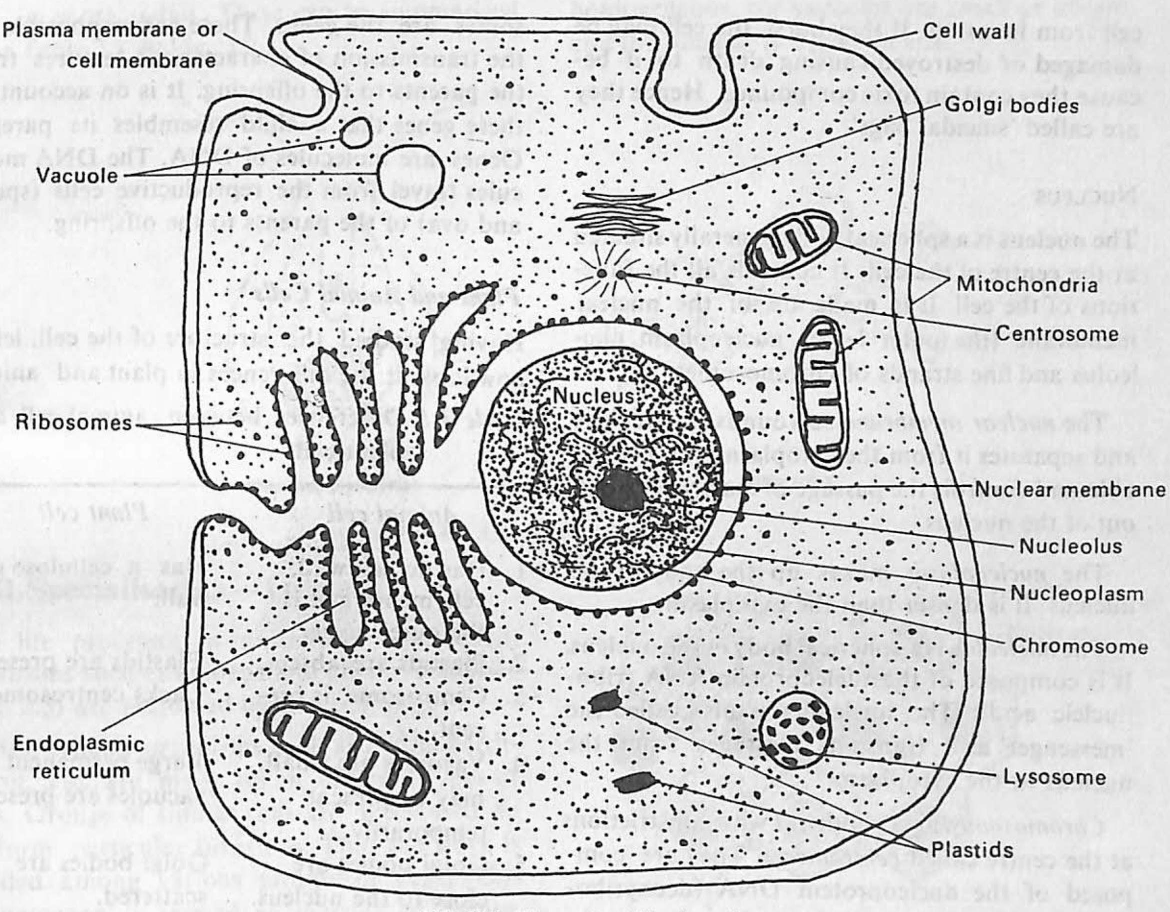


FIG. 3.1 The generalised cell.

CELL ORGANELLES

Mitochondria are important cell organelles in the cytoplasm. They are rod shaped or oval shaped structures concerned with release of energy from food. Hence they are often referred to as the power houses of the cell.

Golgi bodies are organelles whose function is not yet clearly understood. They possess small groups of sacs and are concerned with secretion. They are close to the nucleus in animal cells but scattered in plant cells.

Near the nucleus, a globular *centrosome*, with one or two dot-like centrioles and numerous astral rays are seen in an animal cell. They help in cell division. Centrosome is absent in a plant cell.

Plastids are exclusively present in plant cells. They contain pigments such as *chlorophyll*, *chromophyll* and *leucophyll*; the plastids containing them are *chloroplasts*, *chromoplasts* and *leucoplasts*, respectively. The most important plastids are chloroplasts in leaves, which contain chlorophyll that helps the leaves to manufacture food.

Endoplasmic reticulum is a network of tubules. It extends from the nuclear membrane to the plasma membrane. Like a skeleton it provides shape to a cell.

Ribosomes are found over rough surfaces of the endoplasmic reticulum. They are responsible for protein synthesis.

Lysosomes contain enzymes for cellular digestion. They engulf germs and thus protect the cell from invasion. If they burst, the cell may be damaged or destroyed causing death to it because they contain toxic compounds. Hence they are called 'suicidal bags'.

NUCLEUS

The nucleus is a spherical body generally situated at the centre of the cell. It controls all the functions of the cell. It is made up of the nuclear membrane (the outer layer), nucleoplasm, nucleolus and fine strands of chromosomes.

The *nuclear membrane* surrounds the nucleus and separates it from the cytoplasm. It is permeable and controls the passage of materials in and out of the nucleus.

The *nucleoplasm* makes up the body of the nucleus. It is denser than the cytoplasm.

The *nucleolus* is a spherical body in the nucleus. It is composed of the nucleoprotein RNA (ribonucleic acid). The nucleolus is also called the 'messenger' as it transmits messages from the nucleus to the cytoplasm.

Chromosomes are cylindrical with constrictions at the centre called *centromeres*. They are composed of the nucleoprotein DNA (deoxyribonucleic acid). The hereditary units of chromosomes are the *genes*. These are responsible for the transmission of characteristic features from the parents to the offspring. It is on account of these genes that a child resembles its parents. Genes are molecules of DNA. The DNA molecules travel from the reproductive cells (sperm and ova) of the parents to the offspring.

Plant and Animal Cells

Having studied the structure of the cell, let us now look at the differences in plant and animal

Table 3.1 Differences between animal cell and plant cell.

	Animal cell	*Plant cell*
1.	Has no cell wall; cell membrane is the outer layer.	Has a cellulose cell wall.
2.	Plastids are absent.	Plastids are present.
3.	Centrosome is present.	Lacks centrosome.
4.	Vacuoles are small, may be present temporarily.	Large permanent vacuoles are present.
5.	Golgi bodies are close to the nucleus.	Golgi bodies are scattered.

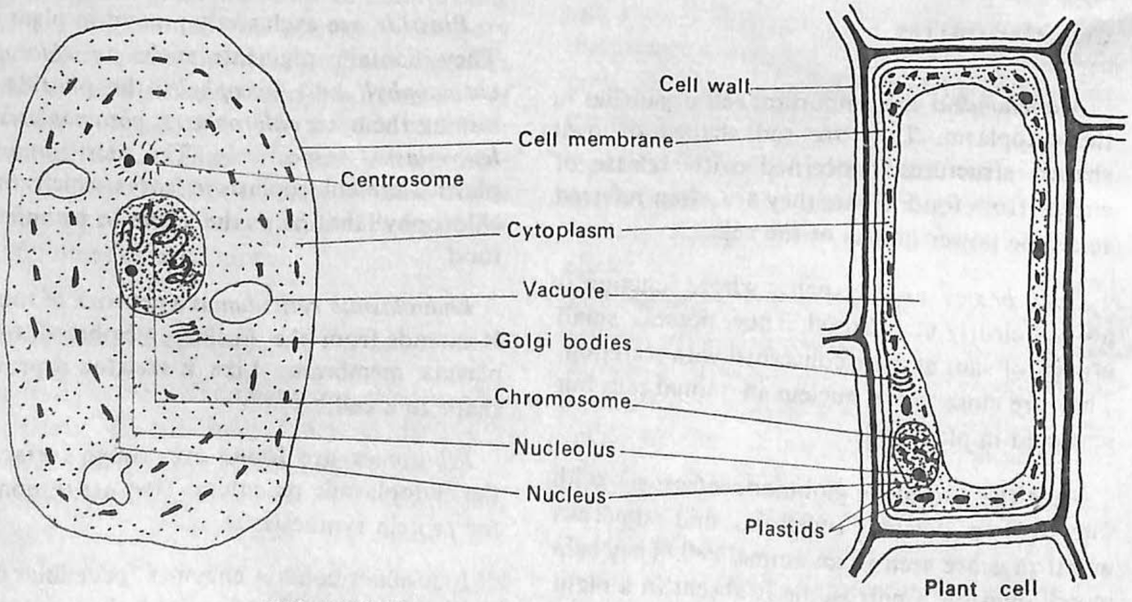
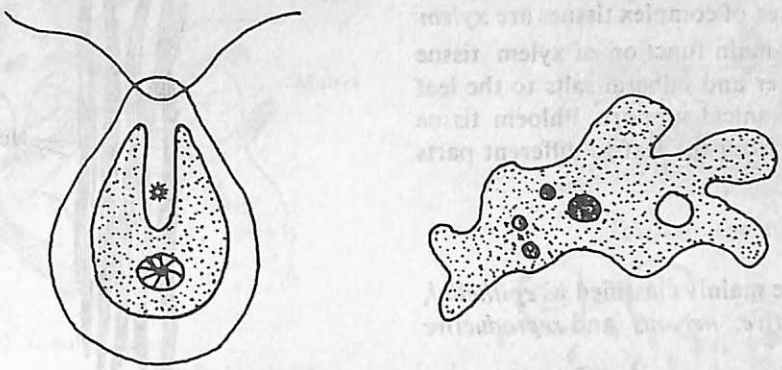


FIG. 3.2 Differences between animal and plant cells.

cells in more detail. These can be summarised as in Table 3.1 & Fig. 3.2.


Chlamydomonas

Amoeba

FIG. 3.3 Unicellular organisms.

Cell Specialisation—Tissues

The life processes in unicellular (one-celled) organisms such as amoeba and chlamydomonas (Fig. 3.3) are perfomed by one cell only.

Multicellular organisms such as hydra, earthworm, etc. are made up of different types of cells. Groups of similar cells are specialised to perform particular functions. Thus the work is divided among various groups of cells. This phenomenon is termed as *division of labour*. This is similar to division of labour in our society, where people are specialised to undertake certain tasks such as teaching, engineering, medicine, business, pottery, etc. A group of cells more or less alike in size and form, and performing similar functions is called a *tissue*.

The tissues in plants differ from those in animals.

Plant Tissues

Plant tissues are primarily classified as *meristematic* and *permanent* tissues.

MERISTEMATIC TISSUES

Meristematic tissues (Fig. 3.4) are found in the *growing regions* of the plants such as the tips of roots and stems. The cells are *immature* and are capable of undergoing division. The cells are spherical, oval or polygonal in shape, with no intercellular spaces. The cell walls are thin and homogeneous, the vacuoles are small or absent, and the nucleus is bigger in size.

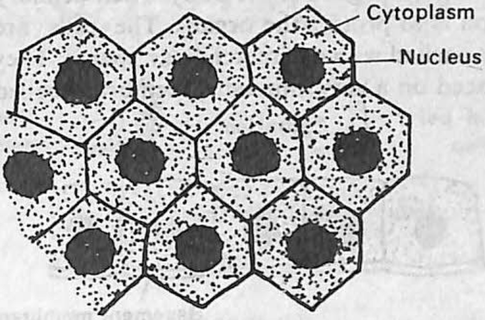


FIG. 3.4 Meristematic tissue.

PERMANENT TISSUES

These consist of *mature* cells which have lost their capacity for division, and have attained their definite form and size. Based on their structure and function they can be classified as *simple*

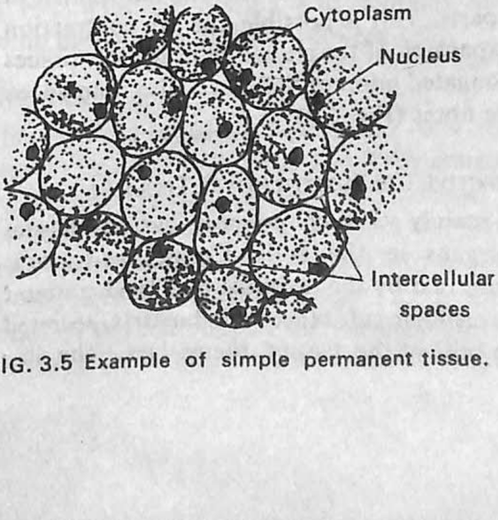


FIG. 3.5 Example of simple permanent tissue.

or *complex* tissues. Simple tissues are composed of similar cells, while complex tissues contain different types of cells working together as a unit. The two types of complex tissues are *xylem* and *phloem*. The main function of xylem tissue is to conduct water and mineral salts to the leaf and provide mechanical support. Phloem tissue transports food from the leaf to different parts of the plant.

Animal Tissues

Animal tissues are mainly classified as *epithelial*, *muscular*, *connective*, *nervous* and *reproductive* tissues.

EPITHELIAL TISSUE

These tissues (Fig. 3.6) form the inner and outer surfaces of the organs of the body. Their primary function is to protect the organs. The cells are closely packed with no intercellular spaces. They are placed on a very thin living membrane called *basement membrane*. This tissue is generally found in those parts where respiration, secretion or excretion take place.

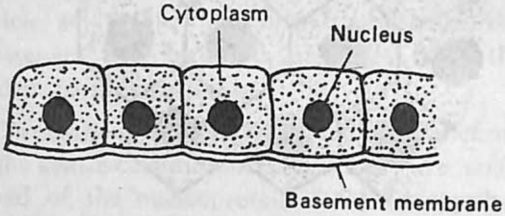


FIG. 3.6 Example of epithelial tissue.

MUSCULAR TISSUE

Muscles are responsible for the movement of body parts. This is possible due to contraction and expansion of the muscle cells. Muscle tissues are elongated and are therefore also known as muscle fibres (Fig. 3.7).

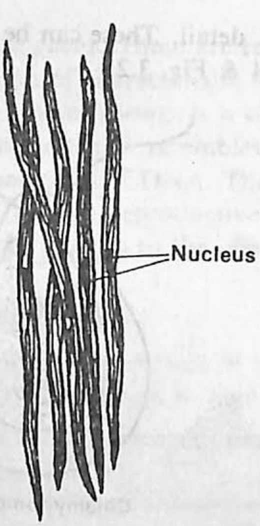


FIG. 3.7 Muscular tissue.

CONNECTIVE (OR SUSTENTATIVE) TISSUE

These mainly serve to connect various tissues and organs in the body. Connective tissue is characterised by the presence of a large amount of intercellular substance called matrix, secreted by the cells of the tissues themselves. The important connective tissues are *areolar*, *cartilage*, *bone*, *blood* and *lymph*.

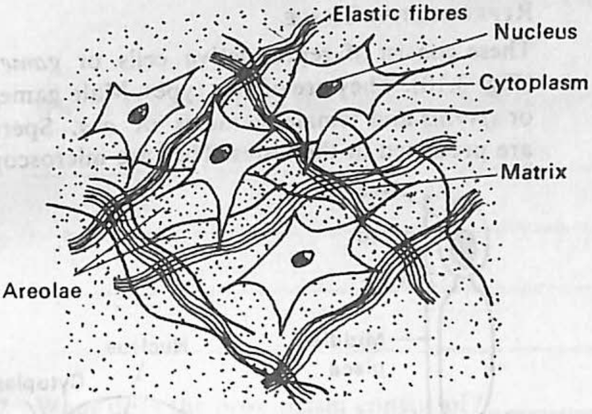
Areolar tissue (Fig. 3.8a) looks like a network of fine threads crossing each other in all directions, leaving small spaces or *areolae* between them. It forms a continuous thin sheet between the skin and muscles and fills up the spaces between many organs.

Cartilage tissue (Fig. 3.8b) is firm and elastic, its chief function being to give support. The deposition of inorganic substances, chiefly calcium makes it slightly hard. Fluid spaces known as lacunae enclose the round cells. Cartilage supports the nasal bridge and the external ear.

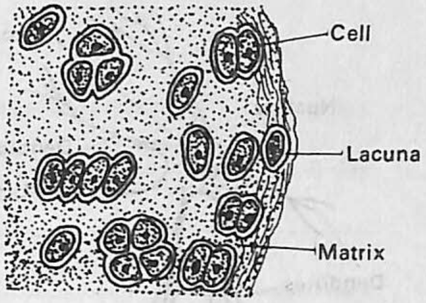
Bone (Fig. 3.8c) is the hardest tissue of the body, supporting or protecting various organs. The matrix is tough, containing salts of calcium and phosphorus. The matrix is arranged in fine concentric layers termed as *lamellae*. Irregular spaces known as *lacunae* can be seen on the lamella.

Each lacuna gives rise to fine branching *canali culi*. The canal and the concentric circles of lacunae make up a *Haversian system*. Several Haversian systems make up the bone.

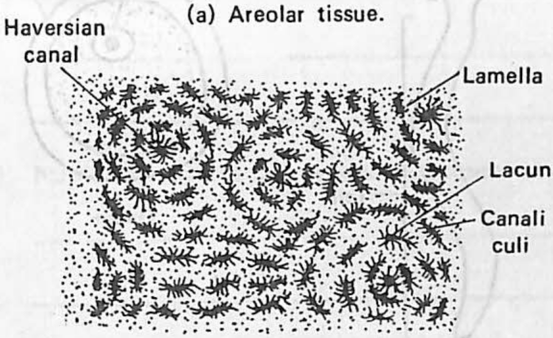
The bone is covered by a tough sheath called *periosteum*. Long bones have central cavities containing *bone marrow* which manufactures red blood cells.



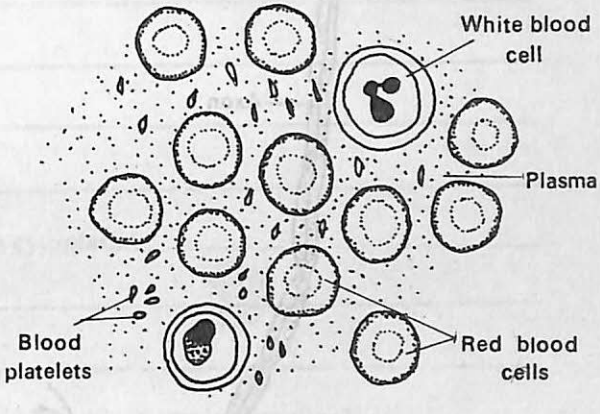
(a) Areolar tissue.



(b) Cartilage tissue.



(c) Bone tissue.



(d) Types of blood cells in man.

FIG. 3.8

Blood (Fig. 3.8d) is a mobile, connective tissue transporting nutritive materials, excretory substances, inhaled and exhaled gases and other substances to all the cells in the body. It is made up of the fluid *plasma* and the *blood cells* (or blood corpuscles). Plasma is yellow in colour, consisting of 90% water, and 10% dissolved solids. The blood corpuscles are red blood corpuscles (RBC or erythrocytes), white blood corpuscles (WBC or leucocytes) and platelets (thrombocytes).

Red blood cells are round and biconcave. RBC in human blood do not have a nucleus. They contain the pigment *haemoglobin* which carries oxygen to various parts of the body. There are about 5 million RBCs per cubic millimetre of blood.

White blood cells are irregular in shape and have a nucleus. They act as protectors of the body by destroying disease producing organisms. There are about 9000 WBC per cubic millimetre of blood.

Platelets are the smallest cells in the blood, helping in clotting of blood if the blood vessels are injured or punctured. The blood clot prevents any further blood from flowing out of the injured part.

Another fluid connecting tissue is the *lymph*. It resembles the plasma and contains mostly white blood cells. It flows between cells.

NERVOUS TISSUE

These consist of highly specialised cells called *neurons* or *nerve cells* (Fig. 3.9). They constitute the nervous system. The nerve cell consists of a cell body with a nucleus and protoplasmic protrusions called *dendrons*, terminating into *dendrites*. A long fibre called *axon*, covered by a sheath, connects the cell body to the terminal branches. Neurons can receive stimuli, conduct impulses

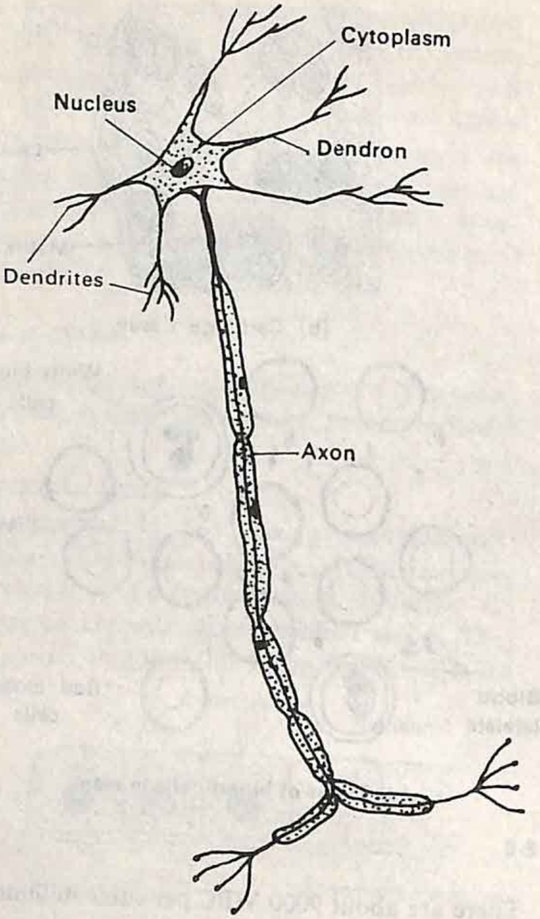


FIG. 3.9 A nerve cell.

from one part of the body to another and discharge these impulses. The stimuli are received by the dendrites and are transmitted through the axon from one part to another.

REPRODUCTIVE TISSUE

These consist of reproductive cells or *gametes* (Fig. 3.10). They are of two types. Male gametes or *sperms* and female gametes or *ova*. Sperms are produced in the testes. They are microscopic cells with a defined head, neck and tail. The ovum or egg is produced by the ovary. It is large in size, covered by a membrane and has an eccentrically situated nucleus. The cytoplasm of the ovum contains reserve food materials.

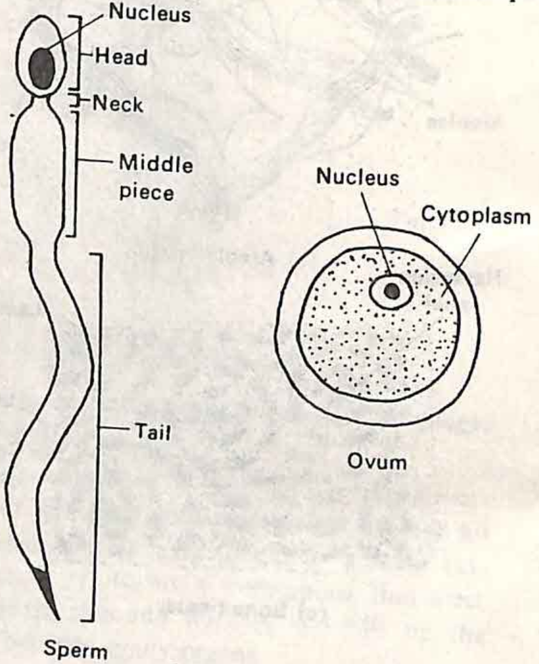


FIG. 3.10 Reproductive cells

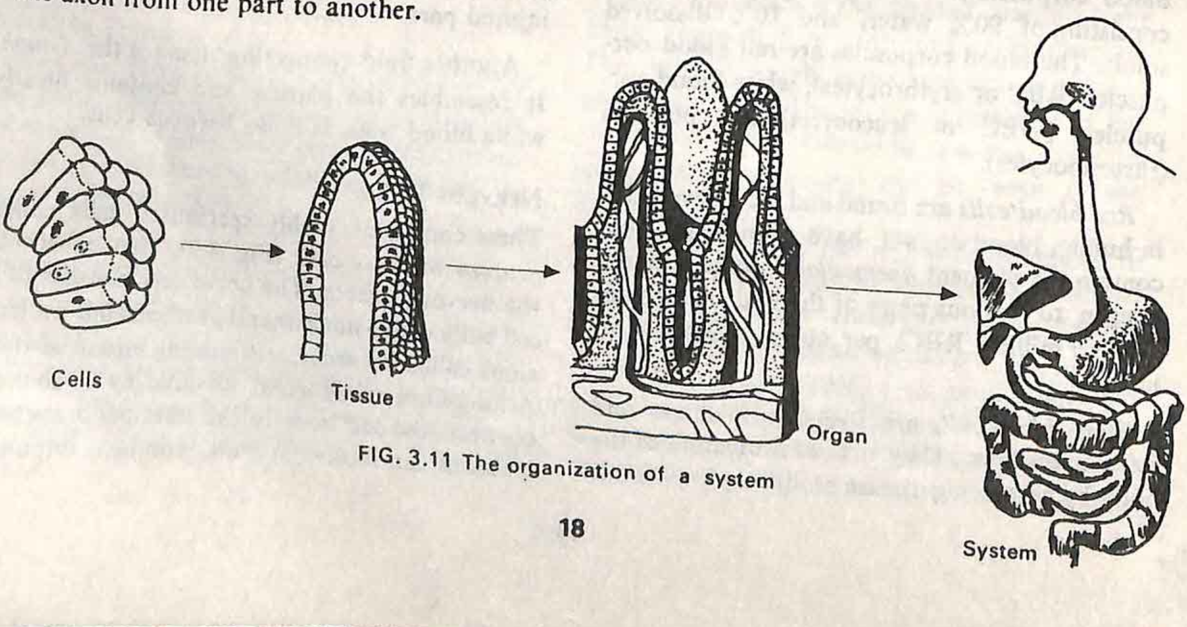


FIG. 3.11 The organization of a system

EXERCISES

1. Why is the cell called the structural and functional unit of plants and animals?

2. What does the protoplasm consist of?

3. Name the various cell organelles present in the cytoplasm?

4. Where is the nucleus of a cell generally situated? What is its major function?

5. What are genes? What is their function?

6. Give two major differences between a plant and an animal cell.

7. What is a tissue?

8. Why are animal tissues different from plant tissues? ____________________

9. How is meristematic tissue different from permanent tissue? ____________________

10. What is the main function of epithelial tissue? ____________________

11. What is the main function of muscular tissue? ____________________

12. What is the function of the bone tissue? ____________________

13. Why is blood called a tissue? What is its importance? ____________________

14. Differentiate between the following:

(a) A bone and a cartilage ____________________

(b) RBC and WBC ____________________

(c) Dendron and dendrite ____________________

4

Simple Flowering Plants

From times immemorial, man has been associated with plants. Several thousand years ago the primitive man cultivated some plants and obtained cereals from them. His interest in plants increased and gradually he started obtaining oils from plants such as mustard and coconut, cotton from fibre plants, medicines from medicinal plants, and timber from trees. His curiosity led him to study the external and internal structure of plants. He began to seek answers to certain questions such as what and how plants eat, how they grow and reproduce, and so on. Thus he started his search for knowledge regarding details of plant life. In this chapter you will learn about the different parts of a plant and how they help the plant in various ways. Although there are several varieties of plants in nature, the basic structure of all of them is the same. The flower-bearing plants are known as *angiosperms.*

The Mustard Plant

This plant grows during the winter months. It grows up to an average height of about 1 metre. Mustard oil is extracted from its seeds.

The body of flower-bearing plants (Fig. 4.1) can be classified into two distinct systems—the *root system* and the *shoot system.*

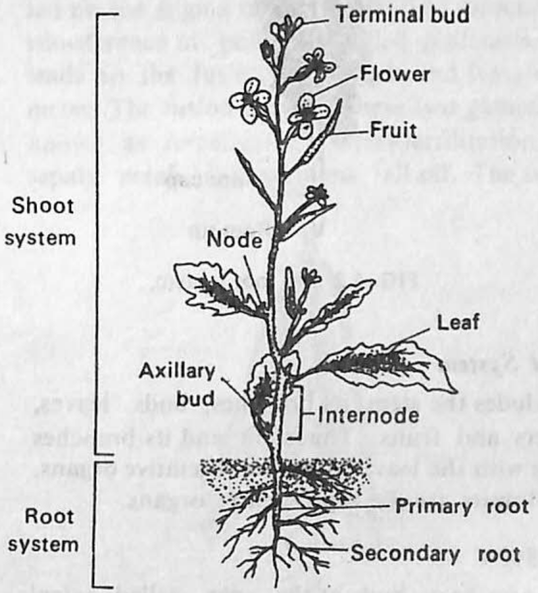


FIG. 4.1 A mustard plant.

Root System

It consists of the *primary* root growing straight into the soil, and its branches. As it travels down it develops slender roots called *secondary* roots.

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Unlike a stem, they are spread haphazardly in the soil. The roots not only fix the plants to the soil but also bind the soil particles. The growth zone of a root, known as the *root tip*, is very delicate and is protected by a *root cap*. A little behind the root cap zone is a zone of *root hair*. The absorption of water and mineral salts is done by the root hair.

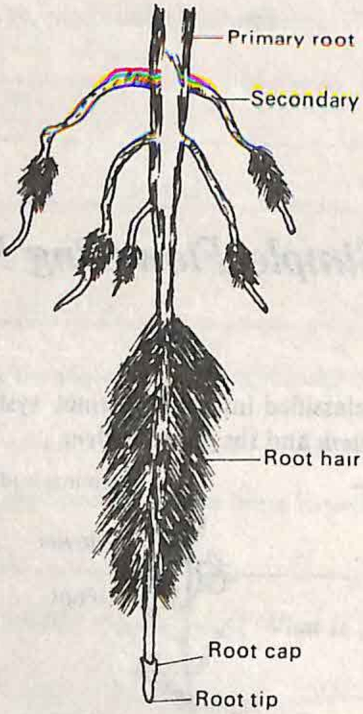


FIG. 4.2 The root system.

Shoot System

It includes the stem, its branches, buds, leaves, flowers and fruits. The stem and its branches along with the leaves form the vegetative organs, and flowers are the reproductive organs.

THE STEM

The stem bears buds at the apex, called *apical buds* or *terminal buds* (Fig. 4.1). These are responsible for growth in length. The angle which the leaves make with the stem is known as the *axil*. Every axil has an *axillary* bud from which branches may arise. The leaves on the stem are arranged in such a way that overlapping is avoided and all the leaves get their share of sunlight. The points on the stem where leaves arise is called a *node*, and the space in between the nodes is called the *internode* (Fig. 4.1).

The stem provides support to the plant. The water and mineral salts absorbed by the roots reach other parts of the plant through the stem. It also provides the path for the movement of food manufactured by the leaves.

THE LEAF

The leaf is a very active part of the plant. It is here that food is manufactured with the help of chlorophyll, the green pigment in a leaf. The energy required for the manufacture of food is absorbed by the leaf from sunlight.

The leaf consists of three parts, the *leaf base*, the *petiole* and the *lamina* (Fig. 4.3). The leaf is attached to the stem by means of the leaf base. The stalk between the leaf base and the body of the leaf is the *petiole*. At the end of the petiole is the flat portion of the leaf known as the leaf blade or *lamina*. It is usually green in colour because of the green pigment chlorophyll. In the middle of the lamina is the *mid rib*, which divides into a number of veins. These in turn divide further to form a network of veinlets, which connect all parts of the leaf.

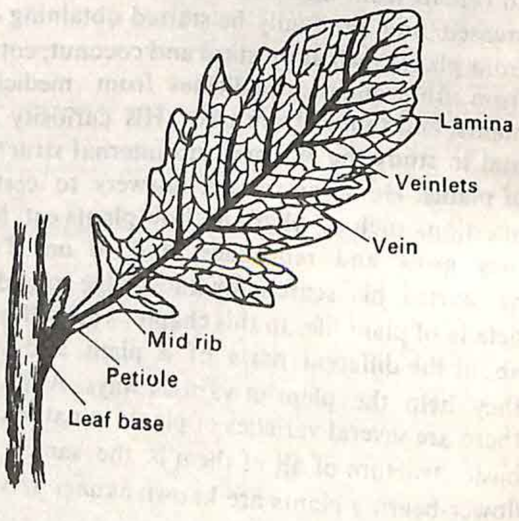


FIG. 4.3 Leaf of a mustard plant.

THE FLOWER

The flower (Fig. 4.4a) is the reproductive part of a plant. The axis of the flower is the *thallamus*, on which four distinctive floral leaves or whorls are arranged. They are *calyx*, *corolla*, *gynoecium* and *androecium*.

(a) *Calyx* is the outermost whorl. It consists of four *sepals* (Fig. 4.4) which are usually green and free from each other. Such sepals are said to be *polysepalous*. Their function is to protect the floral parts during the bud stage.

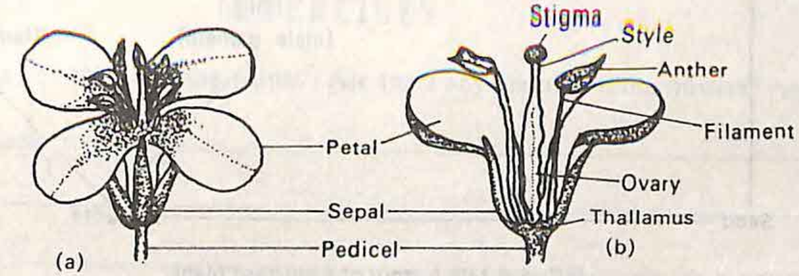


FIG. 4.4(a) The mustard flower. (b) Vertical section of a mustard flower.

(b) *Corolla* lies next to the calyx. It consists of *petals* (Fig. 4.4) which are lemon yellow in colour in a mustard flower. There are four petals free from each other. Such a corolla is said to be *polypetalous*. The bright colour of the petals attract the insects that help in pollination.

Sepals and petals are together called the accessory whorls. They are the non-essential parts of the flower because their only function is to protect the flower and make it attractive.

(c) *Androecium* is the male part of the flower. It is the third whorl, consisting of a number of *stamens* (Fig. 4.4b). Each stamen has a long and thin portion known as the *filament* with a sac-like *anther* attached at the tip. The *pollen sacs* in the anther contain *pollen grains*. These contain the male reproductive cells. Pollen grains are released when the mature anther bursts.

(d) *Gynoecium* (or *pistil*) is the female part of the flower and forms the innermost whorl (Fig. 4.4). It is situated at the centre of the flower. It consists of three parts, the *ovary*, the *style* and the *stigma*. The ovary is tubular and contains *ovules* which form seeds after fertilisation. The style is the thin portion attached to the ovary. At the end of the style is the stigma. It is on the stigma that pollen grains are received.

Androecium and gynoecium are together called the essential whorls as these are involved in reproduction.

The mustard flower contains all four whorls and is therefore termed as a *complete flower*. Since it contains both male and female parts it is known as a *bisexual flower*.

The pollen grains from the anthers are deposited on the stigma of the pistil. The process of transference of pollen is called *pollination*. It leads to the fusion of the male and female gametes. The fusion between these two gametes is known as *fertilisation*. After fertilisation the sepals, petals and stamens fall off. The ovary changes to the fruit (Fig. 4.5) and the ovules to seeds. The fruit when matured bursts and disperses the seeds.

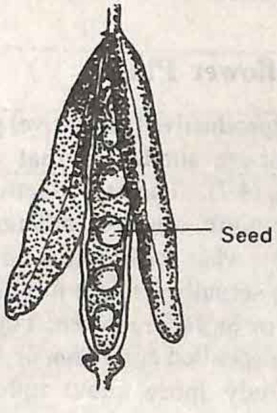


FIG. 4.5 The mustard fruit.

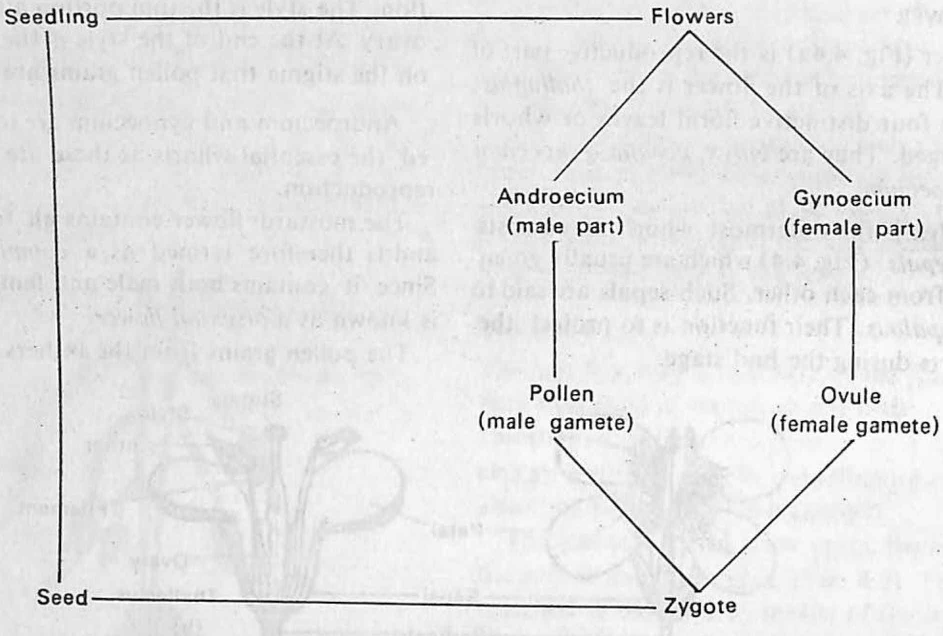


FIG. 4.6 Life history of a mustard plant.

INFLORESCENCE

In a mature mustard plant, flowers develop in a bunch at the end of the stem and its branches. A cluster of such flowers is known as *inflorescence*. In a mustard plant new flowers develop at the tip while the old flowers at the base of the inflorescence change to fruits. Such an inflorescence is called a *racemose inflorescence*.

The Sunflower Plant

The non-reproductive (vegetative) parts of a sunflower plant are similar to that of a mustard plant (Fig. 4.7). The reproductive parts of the shoot system are, however, different. In the sunflower plant, what looks like a flower to a layman is not actually a single flower, but a bunch of flowers or an *inflorescence*. This type of inflorescence is called *capitulum* or *head* (Fig. 4.8). We shall study more about inflorescence in a later chapter.

The sunflower inflorescence has a flattened convex disc known as a *receptacle*, in which small flowers known as *florets* are arranged. The florets are of two types: *ray florets* towards the

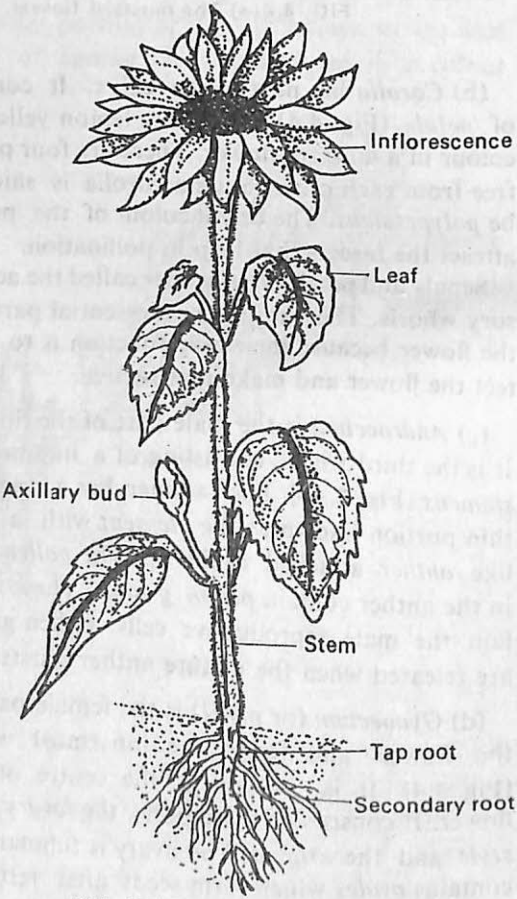


FIG. 4.7 The sunflower plant.

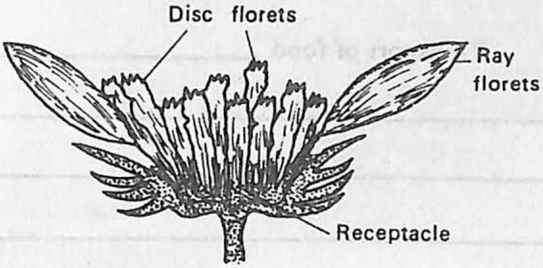


FIG. 4.8 Capitulum of sunflower.

periphery and *disc florets* towards the centre. On fertilisation, each floret develops into a fruit.

EXERCISES

1. What do you mean by 'flowering plants'? Are there any plants without flowers? Answer from your observations in nature. ____________________

____

____

2. Name any two oil yielding plants. ____________________

3. Name the systems in an angiosperm plant. ____________________

____

4. What do you mean by a flower being 'complete'? ____________________

____

5. What is a bisexual flower? Give an example. ____________________

____

____

6. Name the growth zone of a root. ____________________

7. Name the different types of buds and say where they are situated. ____________________

____

____

____

8. Name the organs in a plant which help in carrying out the following processes.

Photosynthesis ____________________ Reproduction ____________________

Absorption of water ________________ Transport of food ________________

9. Why is a leaf called a factory? ________________

10. Name the various parts in

(a) Gynoecium ________________

(b) Androecium ________________

11. What is pollination? ________________

12. What are the reproductive organs in a flower? ________________

13. What is inflorescence? ________________

14. Draw labelled diagrams of (a) a mustard plant (b) a sunflower plant.

5

Plant Parts and Their Modifications

Earlier we studied about the parts of a flowering plant in general. Now we shall study further details regarding the structure, functions and modifications of each part of the plant.

The Root

The root is the underground part of the plant (Fig. 5.1). It anchors the plant in the soil and absorbs water and mineral salts. The area occupied by the network of roots (known as the *root system*) is in no way less than that occupied by the aerial parts. The root system consists of the *primary root* on which *secondary roots* and *root hair* grow. The growing part of the root is the *root tip*. The root tip is very delicate and is protected by a *root cap*.

Kinds of Roots

There are two kinds of roots, the *tap root* and the *adventitious root*.

In the *tap root* (Fig. 5.2a), the primary root grows as the main root. The upper part of the primary root is thick, with mature cells. The lower part tapers gradually and develops secondary roots. Brinjal, radish, carrot, etc. are examples of tap roots.

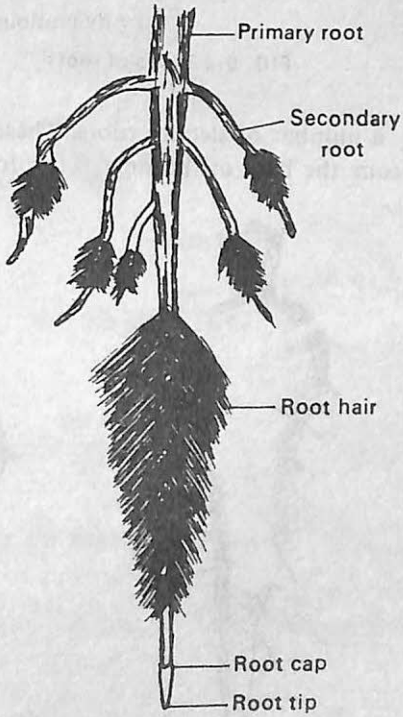
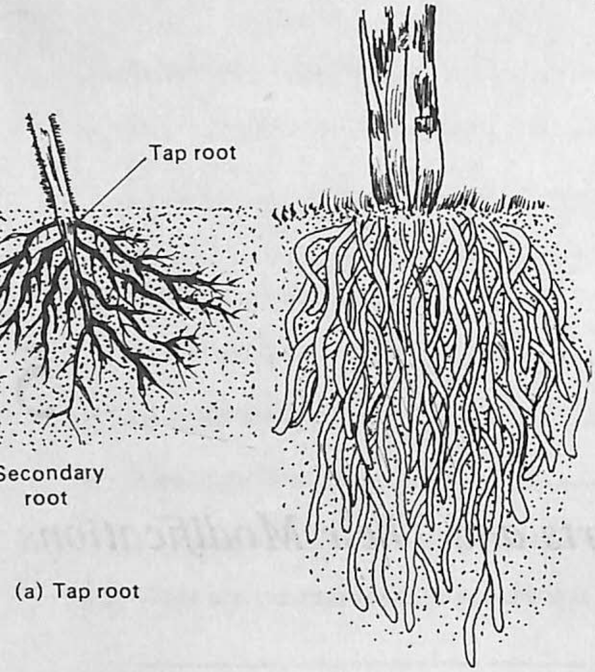


FIG. 5.1 The root and its parts.

In the *adventitious root* (Fig. 5.2b), the primary root is short-lived and is replaced after some



(a) Tap root

(b) Adventitious root

FIG. 5.2 Types of roots

time by a number of slender roots. These roots arise from the base of the stem. They form the fibrous root system that can be seen in wheat, maize, grasses, etc.

Modifications of the Root

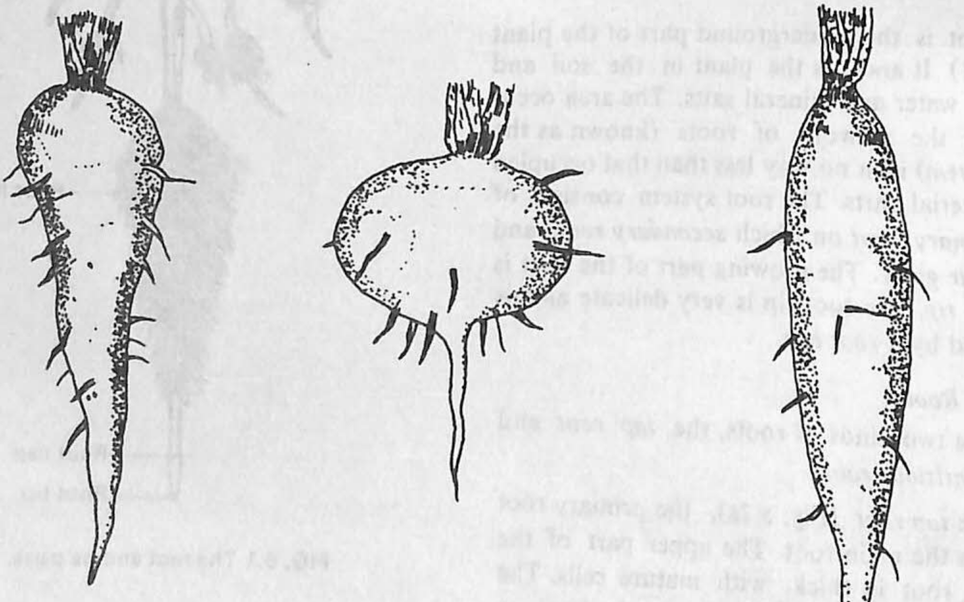
Roots may show modifications in their structure and function to adapt to various conditions. Here we will study modifications from two points of view—storage of food and mechanical support.

STORAGE ROOTS

The tap roots of carrot, turnip, radish, etc., are swollen and fleshy as they store food (carbohydrates) (Fig. 5.3). Cone shaped storage roots, for example that of carrot, are known as *conical roots*. The storage roots of turnip are spherical in shape and taper abruptly at the lower end. Such roots are called *napiform*. The roots of radish are swollen in the middle and taper towards the ends. These type of roots are called *fusiform*.

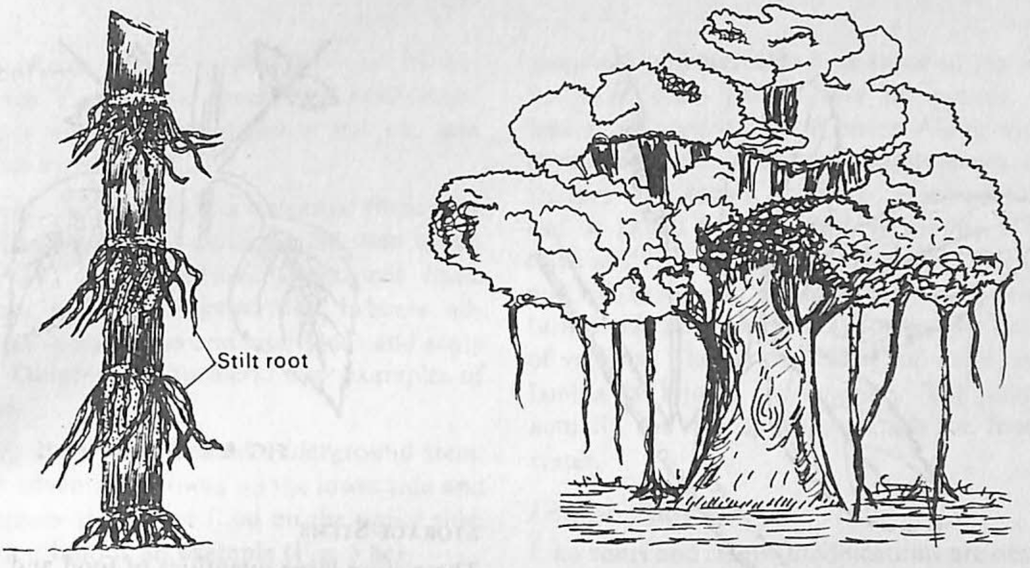
SUPPORTING ROOTS

(i) *Stilt roots*: Roots in the maize plant and the screw pine develop from the lower nodes of the stem and support the plant. Such roots are called *stilt roots* (Fig. 5.4a).



Conical—Carrot Napiform—Turnip Fusiform—Radish

FIG. 5.3 Stroage roots



(a) Stilt root in maize (b) Prop roots of the banyan tree

FIG. 5.4 Supporting roots

(ii) *Prop roots:* These arise on the horizontal branches of the tree, for example the banyan tree. They are aerial roots which hang in the air. Once they reach the ground, they fix themselves to the soil giving support to the heavy branches of the tree.

The Stem and Buds

The stem forms the aerial portion of a plant from which may grow a number of branches which bear leaves, flowers, etc. The stem, its branches, leaves, buds, flowers and fruits together form the shoot system of the plant. The stem bears *apical buds* or *terminal buds* at the apex. These are responsible for growth in length. Every axil contains an *axillary bud* from which branches may arise. The points where leaves arise is the *node* and the space between two nodes is the *internode* (Fig. 5.5).

The stem provides support to the plant. It also provides a path for the movement of water and mineral salts from the roots to the leaves, and food materials from the leaves to the roots.

Modifications of the Stem and Bud

The stem and buds also show modifications in their structure to perform various functions. Here we will study modifications from the point of view of support, defence and storage of food.

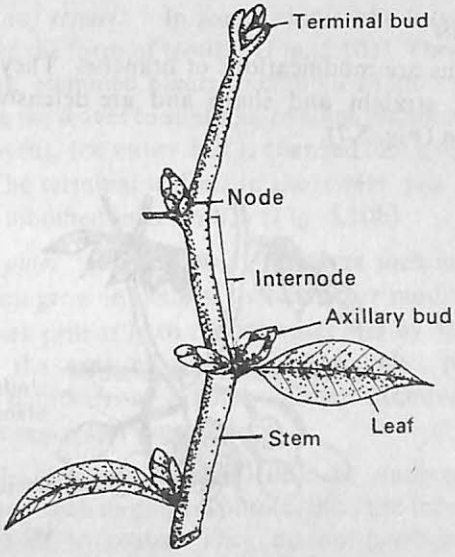


FIG. 5.5 The stem showing buds

STEM TENDRIL

In some plants which have weak stems, such as passion flower, the axillary buds are modified into coiled structures known as *tendrils.* They coil around objects and thus support the plant (Fig. 5.6).

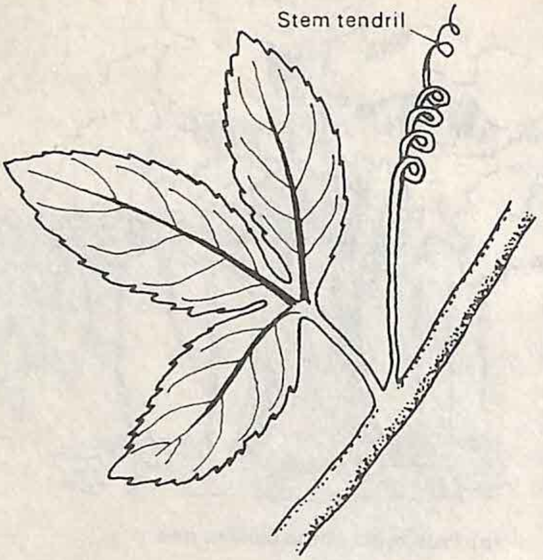


FIG. 5.6 Stem tendril of passion flower

THORN

Thorns are modifications of branches. They are hard, straight and sharp and are defensive in action (Fig. 5.7).

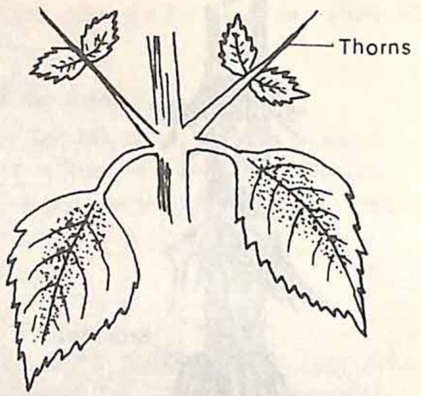
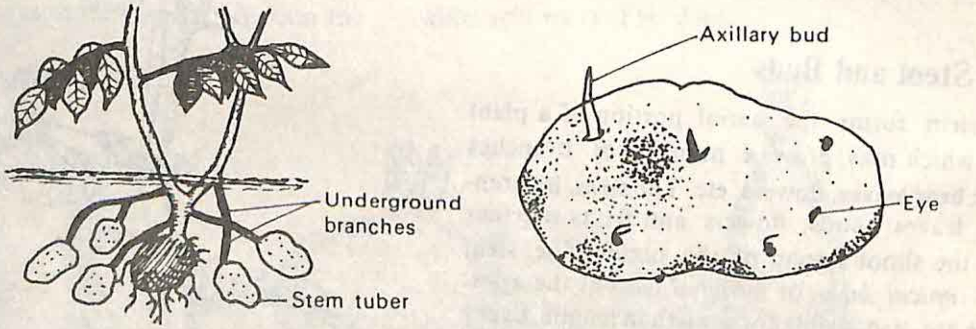


FIG. 5.7 Thorns

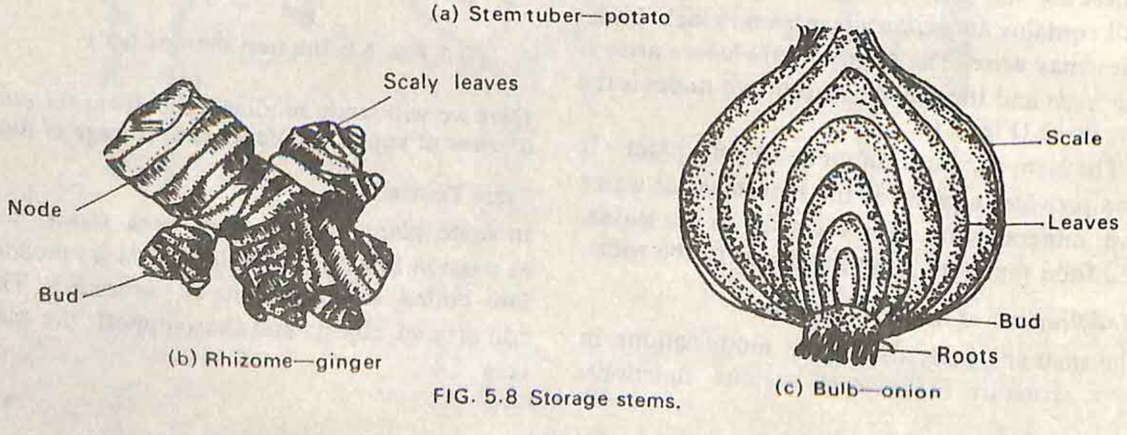
STORAGE STEMS

These store large quantities of food and are of three main types—*tubers*, *rhizomes* and *bulbs*. These modified stems remain under the ground.

Stem tubers: Potato (Fig. 5.8a) is a modified stem called *stem tuber*. Tubers develop at the end of branches emerging from nodes under the soil. They remain underground and store food. Being underground they are saved from grazing



(a) Stem tuber—potato



(b) Rhizome—ginger

(c) Bulb—onion

FIG. 5.8 Storage stems.

animals. Each tuber has several pits on its surface called 'eyes'. These contain dormant buds. Each 'eye' when cut and placed in the soil can grow into a new plant.

Rhizome (Fig. 5.8.b) is a perennial (living for more than two years) underground stem which may or may not be branched. It becomes thick and fleshy due to storage of food. It bears adventitious roots, nodes and internodes and scaly leaves. Ginger and turmeric are examples of rhizome.

Bulb: It is a condensed underground stem. It bears adventitious roots on the lower side and fleshy leaves that store food on the upper side. The onion bulb is an example (Fig. 5.8c).

Leaf

Leaves are the most prominent and important parts of a plant. They perform several functions including the vital function of manufacturing food for the whole living world. They are generally thin, flat and green. They are arranged on the stem according to their age—the older ones at the base and the younger ones at the growing point. In some plants they are arranged opposite to each other, in others alternately, and in still others all around the stem.

Parts of a Leaf

The leaf is attached to the stem at the node, with the help of the leaf base and a stalk called *petiole.* Some leaves such as those of maize and monocotyledon plants have no petiole. Such leaves are called *sessile leaves*. Along with the petiole are seen a pair of small leaves called *stipules*. The broad, expanded green part of the leaf is called the *leaf blade* or *lamina*. It has a thick *mid rib* in the centre. On either side of the mid rid, thin veins branch out. The veins in turn divide and subdivide to form a fine network of veinlets. The arrangement of veins in the lamina is known as *venation*. The veins are actually the transporting vessels for food and water.

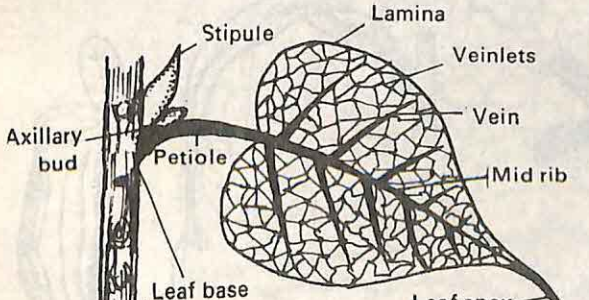


FIG. 5.9 Parts of Pipal leaf

Leaf Modifications

Like roots and stems, modifications are observed in leaves also. Leaves are modified to climb (in search of sunlight), to prevent excessive loss of water, or to defend the plant body from enemies.

Leaf tendril: In some plants the leaves assume the form of tendrils (Fig. 5.10a). These help weak stemmed plants to climb a support to expose the leaves to sunlight. In some plants such as lathyrus, the entire leaf is changed into a tendril.

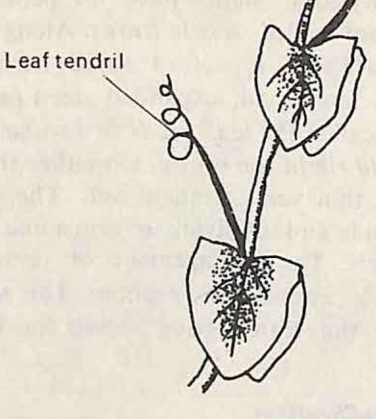
The terminal leaflets in the sweet pea plant are modified into tendrils (Fig. 5.10b).

Spines (Fig. 5.10c): In plants such as cacti which grow in deserts, the leaves are modified to spines primarily to reduce water loss by decreasing the area of the leaf. They also protect the plants from animals. Other examples are asparagus and pineapple.

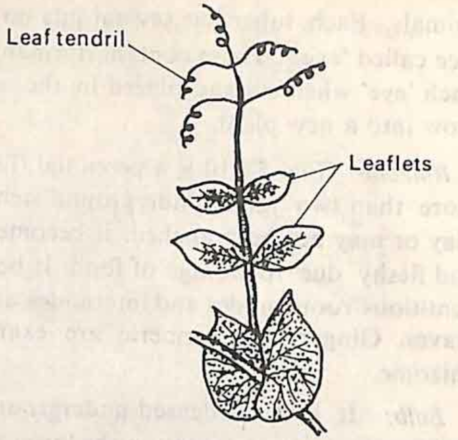
Scale leaves (Fig. 5.10d): In underground plants such as ginger, potato, etc., the leaves are reduced to scales. They do not perform their normal function, and only cover and protect the axillary buds.

Phyllode: When the leaf petiole takes on the form and function of a leaf, it is called a phyllode. In case of Australian Acacia (Fig. 5.10e) this gradual transformation of the petiole into the phyllode can be observed in the seedling stage. Phyllode is green and manufactures food like a leaf.

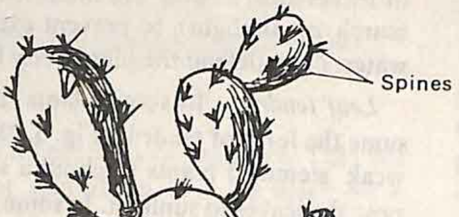
Pitcher and leaf traps: Some plants, for example Nepenthes, trap and digest insects to



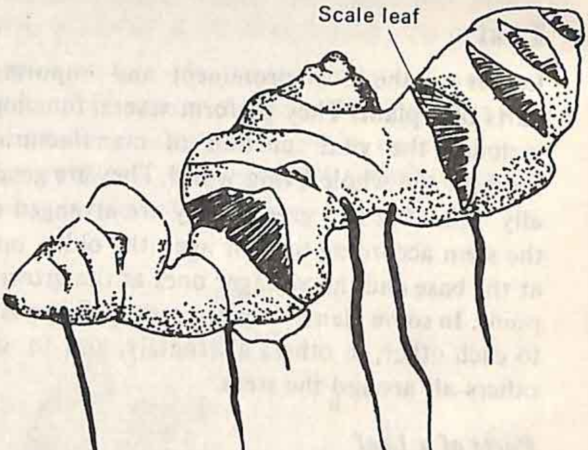
(a) Leaf tendrils of wild pea (lathyrus)



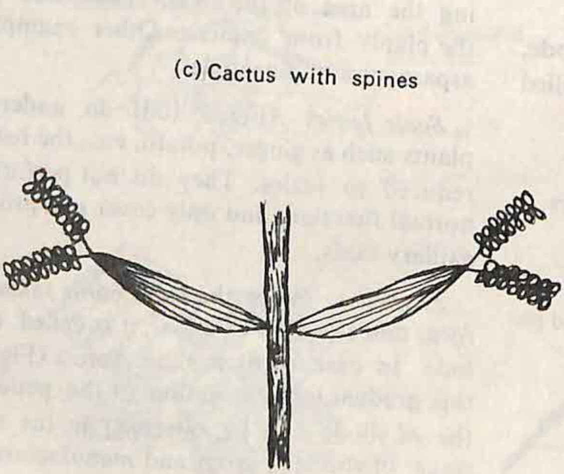
(b) Terminal leaflet tendrils of sweet pea



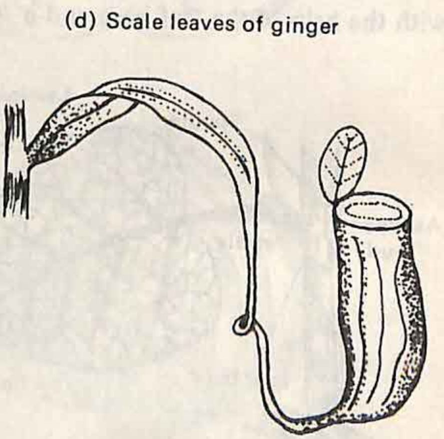
(c) Cactus with spines



(d) Scale leaves of ginger



(e) Phyllode



(f) Pitcher of Nepenthes.

FIG. 5.10 Modifications in the leaf

get their nitrogen supplies. In these plants the entire leaf or only a part of it is modified into a pitcher (Fig. 5.10f) which helps to trap insects.

Internal Structure of Leaf

The internal structure of the leaf (Fig. 5.11) can be divided into the following parts.

The *upper epidermis* is a single layer of cells closely arranged with no air spaces between them. It is coated with a waxy cuticle which reduces water loss through evaporation, maintains the shape of the leaf and protects the cells inside from bacteria, fungi and mechanical damage. The epidermal cells do not contain chloroplasts and are transparent. Sunlight can pass through to the cells inside that contain chloroplasts.

Palisade cells are immediately below the upper epidermis. They are one or more rows of elongated cells and have narrow air spaces in between them. Palisade cells contain a large number of chloroplasts lining the walls of the cytoplasm. They receive and absorb most of the sunlight. Chlorophyll, the green pigment in the chloroplast, which is responsible for the green colour of the leaf, absorbs energy and uses it in th chemical build up of sugars and starch. Thus th palisade cells are responsible for *photosynthesis*

Below the palisade calls are *spongy* cells whic are arranged with large air spaces. They are i contact with the openings on the lower leaf surface called *stomata* and thus with the atmosphere. They therefore allow air to circulate an reach the palisade cells for manufacturing food.

The *lower epidermis* of the leaf has openings called *stomata* (Singular: *stoma*) (Fig. 5.11). Each stoma is surrounded by two *guard cells* which contain chlorophyll. The guard cells control the opening and closing of the stomata.

The midrib and its network of veins conduct water into the leaf and food away from it. They consist of vascular bundles called *xylem* and *phloem*, which transport water and food respectively.

Functions of a Leaf

The leaf performs the functions of photosynthesis, respiration and transpiration.

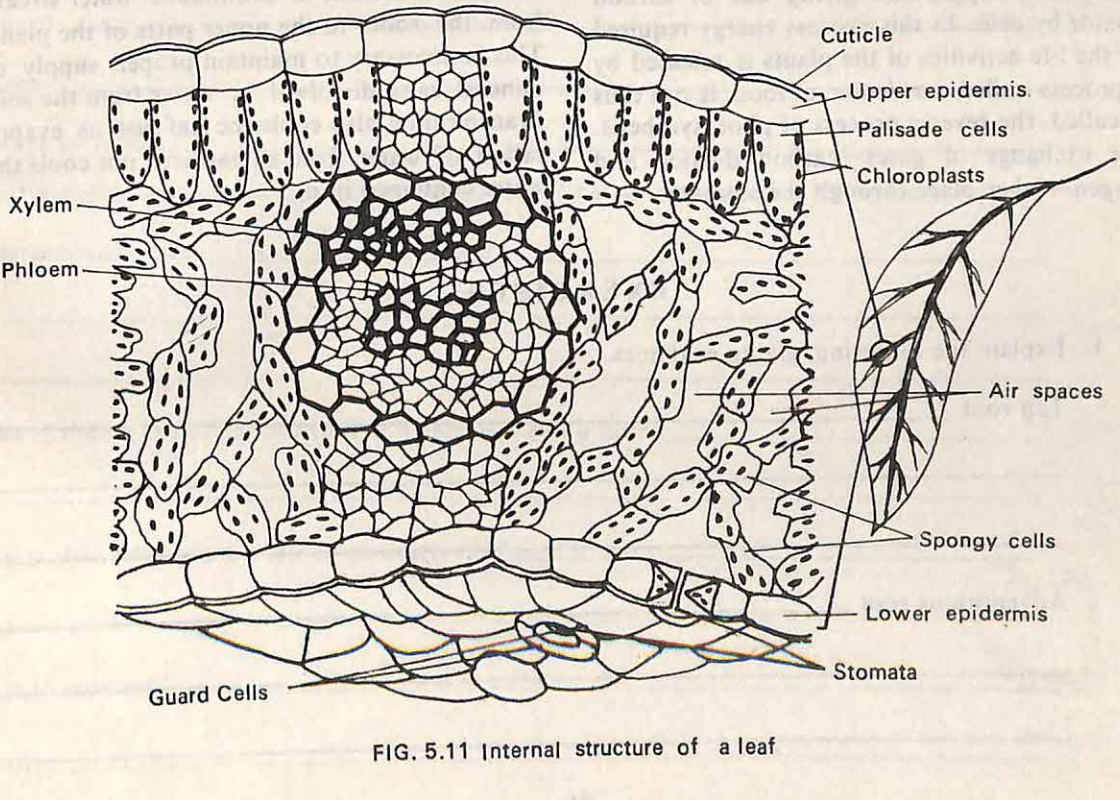


FIG. 5.11 Internal structure of a leaf

(a) *Photosynthesis:* Photosynthesis is the single most important process not only for the plants but to all living beings in the world It is a biochemical reaction taking place in a leaf to manufacture food without which there can be no life at all. The green colour of leaves is due to the presence of chlorophyll in the chloroplasts of the palisade cells. Chlorophyll helps the plant to use the energy of sunlight to produce carbon containing compounds such as sugar and starch from simple substances such as carbon dioxide and water. The following formula explains how photosynthesis takes place in a leaf.

$$\begin{matrix}\text{water} + \\ \text{carbon dioxide}\end{matrix} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \text{sugar} + \text{oxygen}$$

The carbon dioxide needed for photosynthesis is obtained from the atmosphere through the stomata. During photosynthesis, oxygen is released as a by product. This escapes into the atmosphere through the stomata. Thus the atmosphere around the green plants becomes oxygen-rich and gets purified.

(b) Respiration: Respiration is the process of taking in of oxygen and giving out of carbon dioxide by cells. In this process energy required for the life activities of the plants is released by a process called *oxidation* of food. It can thus be called the reverse process of photosynthesis. The exchange of gases—carbon dioxide and oxygen—takes place through the stomata.

(c) Transpiration: Roots absorb large amounts of water from the soil. Only a fraction of it is used by the cells of the leaves to manufacture carbohydrates. Most of the water absorbed is lost by the aerial parts of the plant, especially through the stomata of the leaves, in the form of water vapour. This evaporation of water in gaseous form through stomata of the leaves is called transpiration.

The factors that affect transpiration are humidity of the air, temperature, wind, light and other internal factors. Transpiration in plants is considered both a necessary evil as well as a useful activity for the plant. Under conditions of water scarcity, loss of water by transpiration becomes a most serious problem. For example, in unfavourable seasons the deciduous trees have to shed their leaves to conserve their water supply, even at the cost of reducing their photosynthetic activity. In desert plants such as cacti, leaves are modified to form spines so as to reduce their surface area and minimise loss of water by transpiration.

Transpiration is advantageous to the plant because it maintains a continuous water stream from the roots to the upper parts of the plant. This is necessary to maintain proper supply of mineral salts dissolved in water from the soil. Transpiration also cools the leaf just as evaporation of water from an earthern pot cools the water contained in it.

EXERCISES

1. Explain the following, giving examples.

Tap root

Adventitious root

2. What is the common function of the roots in radish, beetroot and carrot? ______________

3. Explain the following, giving examples.

Stilt root ______________

Prop root ______________

4. Name any three edible roots and three edible stems. ______________

5. Name one modification each in the stem to perform the following functions. Give examples.

Support ______________

Defense ______________

Storage of food ______________

6. What are stems such as potato and ginger called? What is their function? Why do they grow underground? ______________

7. What is the main difference between a rhizome and a bulb? ______________

8. How is the cactus plant adapted to desert life? ______________

9. What is venation? ______________

10. In what type of plants are leaves adapted to tendrils? What is their function? ______

______

______

11. Name a plant that traps and digests insects. How is the insect trapped? ______

______

______

12. What are the functions of the upper epidermis of a leaf? Which cells in the leaf manufacture food? ______

______

______

13. Why are stomata so important? ______

______

14. What is photosynthesis? Why is it so important? ______

______

______

______

15. What is respiration? Why is it necessary? ______

______

______

16. What is transpiration? How is it useful to the plant? ______

______

______

______

6

The Plant Kingdom

What is Classification?

The surface of the earth is inhabited by a great variety of living organisms. Some of them, such as amoeba or chlamydomonas are so small that they can be seen only under the microscope; others, such as the whale or the banyan tree, are huge. It is therefore very difficult to understand and remember about each and every living organism. It is convenient to classify them into different groups based on common characteristics shared by all members of that group. We can then study the properties of the group instead of studying individual organisms. The branch of biology dealing with classification of living organisms is known as *taxonomy*.

All living organisms can be divided into two main groups, called the *animal kingdom* and the *plant kingdom*. These are further classified into groups called *phyla* (singular: phylum).

Classification of the Plant Kingdom

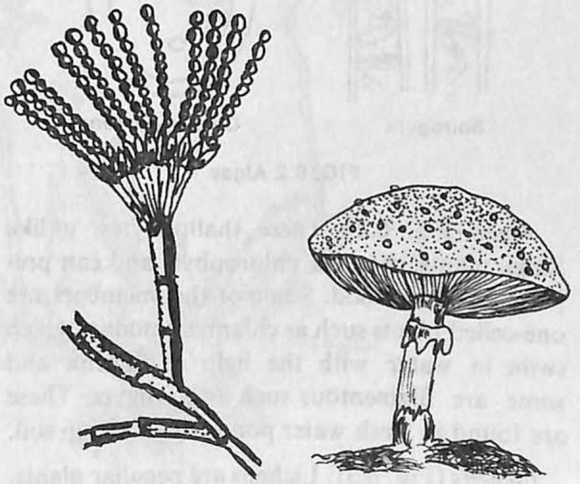
The plant kingdom is classified into four major groups (phyla). These are as follows.

(i) Thallophyta
(ii) Bryophyta
(iii) Pteridophyta
(iv) Spermatophyta

Thallophytes are the simplest plants whereas spermatophytes are the most complex.

THALLOPHYTA (Thallus = body; phyton = plant)

The plants belonging to this group are the simplest and most primitive. Their body (or thallus) is not differentiated into roots, stem and leaves. Their body is made up of one or many cells.



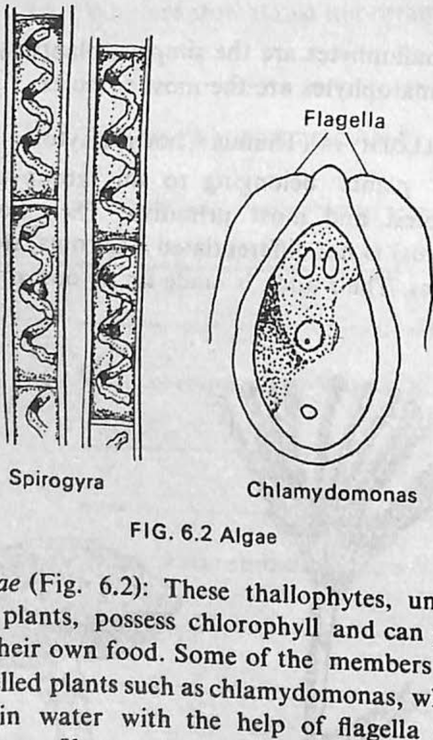
Penicillium Mushroom

FIG. 6.1 Fungi

These plants grow on moist wood, foodstuffs or on animal excreta. Thallophyta is further classified as *fungi*, *algae*, *lichens* and *bacteria*.

Fungi (Fig. 6.1): Rhizopus (common mould), mushroom, penicillium, puccinia (rust fungus) and ringworm are examples of fungi plants.

They are non-green thallophytes having no chlorophyll. As a result they cannot prepare their own food. Some of them, such as rhizopus, obtain their food from dead or decaying matter. Such organisms are called *saprophytes*. Some obtain their food from living plants (e.g. puccinia) or living animals (e.g. ringworm). They are said to be *parasites*. Parasitic fungi harm the crop plants and also cause diseases in man. Some fungi such as penicillium from which the life saving drug called penicillin is produced, are very useful. Some species of mushrooms are edible.



Spirogyra Chlamydomonas

FIG. 6.2 Algae

Algae (Fig. 6.2): These thallophytes, unlike fungi plants, possess chlorophyll and can prepare their own food. Some of the members are one-celled plants such as chlamydomonas, which swim in water with the help of flagella and some are filamentous such as spirogyra. These are found in fresh water ponds or on damp soil.

Lichens (Fig. 6.3): Lichens are peculiar plants, resulting from the association of fungus and algae plants. Both of them live mutually with a 'give and take' policy. This phenomenon of mutual relationship which is beneficial to both partners is called *symbiosis* or *mutualism*. Fungi absorb moisture from the atmosphere and supply it to the algae. The algae use it to manufacture food, which in turn is supplied to the fungi.

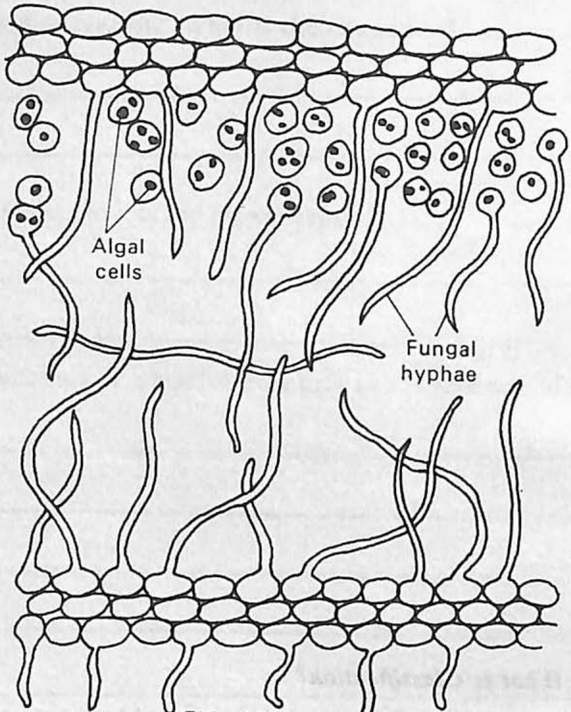
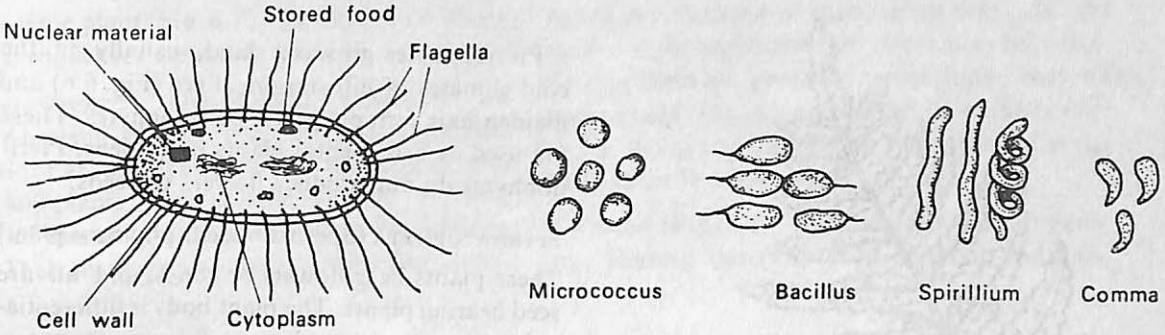


FIG. 6.3 Lichen

Lichens are found on dry and naked rocks and on branches of trees.

Bacteria (Fig. 6.4): These are single celled plants. They are present everywhere—in air, soil, water, foodstuffs and in living bodies. Some bacteria swim in water by means of flagella.

The bacterial cells (Fig. 6.4a) possess distinct cell wall with no cellulose in them. They do not possess a well developed nucleus, as in organisms of higher forms. However they have the essential nuclear material or chromatin matter. The cells generally lack chlorophyll, but some bacteria also have chlorophyll. The bacteria with no chlorophyll have to depend on external sources for food. Therefore their nutrition has to be saprophytic or parasitic. The green pigmented bacteria carry on autotrophic nutrition. The shape of bacteria is varied—some are rod-



(a) A bacterial cell

(b) Bacteria with different shapes

FIG. 6.4 Bacteria

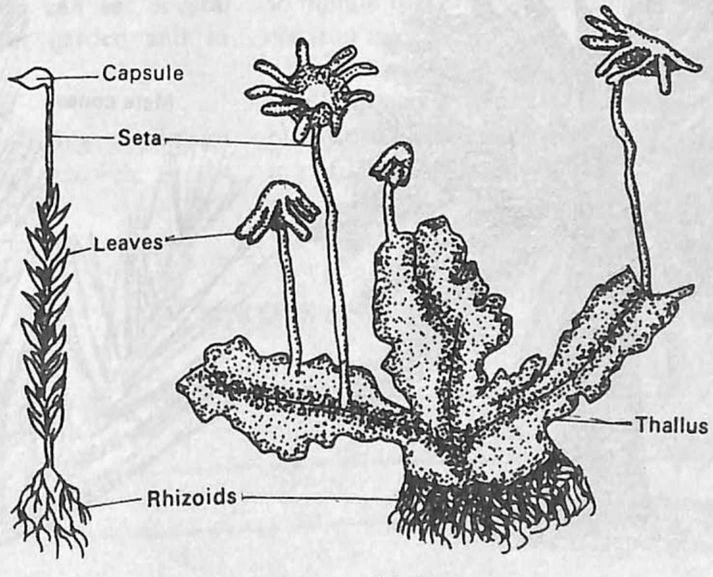
shaped, some are spherical and some are spiral-shaped (Fig. 6.4b).

Bacteria can be useful to us in many ways. *Lactobacillus acidophillus* helps in converting milk to curds. Several bacteria are harmful to us and can cause serious diseases. *Vibrio cholerae* for example causes cholera.

BRYOPHYTA (Bryon = a moss; phyton = plant)
These plants are much more advanced than thallophytes. They grow on moist soil or in water. The plants are fixed to the soil by fine thread-like structures called *rhizoids*. The body possesses stem-like structures called *seta*, leaves and a capsule at the apex, bearing tiny spores. These spores help in reproduction. Some of the bryophytes are mosses, liverworts and riccia (Fig. 6.5 a, b).

PTERIDOPHYTA (Pteron = feather or wings; phyton = plant)

Pteridophytes are more advanced plants than bryophytes. The plant body is clearly differentiated into roots, stem and leaves. The body of the plants consists of water and food transporting tissues.



(a) Moss

(b) Liverwort

FIG. 6.5 Bryophytes

Pteridophytes grow on land, usually in the cold climates of hill stations. Fern (Fig. 6.6) and maiden-hair fern plants are pteridophytes. These are used as ornamental plants in gardens. Pteridophytes do not produce flowers or seeds.

SPERMATOPHYTA (Sperma = seed; phyton = plant)

These plants bear flowers or cones, and all are seed bearing plants. The plant body is differentiated into roots, stem, leaves, flowers or cones. The spermatophytes are further classified as *gymnosperms* and *angiosperms*.

Gymnosperms (Fig. 6.7): the tall, conical, beautiful trees, growing profusely in the hill stations of Kodaikanal, Simla, Nainital, etc. are gymnosperm plants. All the cone-bearing plants such as cycas, pines and fir trees belong to this group. They resemble angiosperm plants in many ways. In both, the plant body is made up of roots, stem, leaves, and seeds. The seeds in these plants, however, are said to be *exposed* or *naked*, unlike angiosperm plants where the seeds are *enclosed* in a fruit. The gymnosperm plants bear male cones and female cones (the reproductive organs)

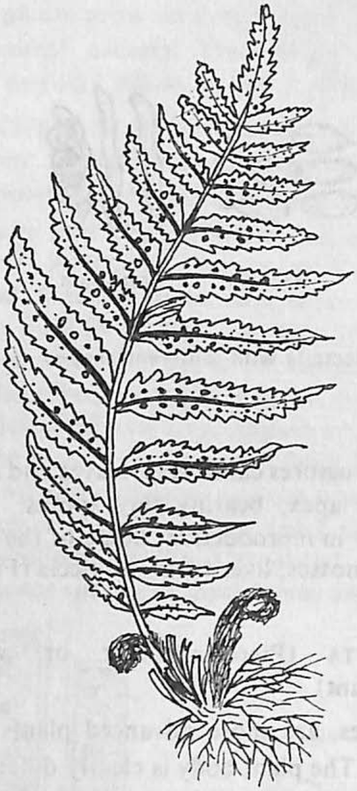
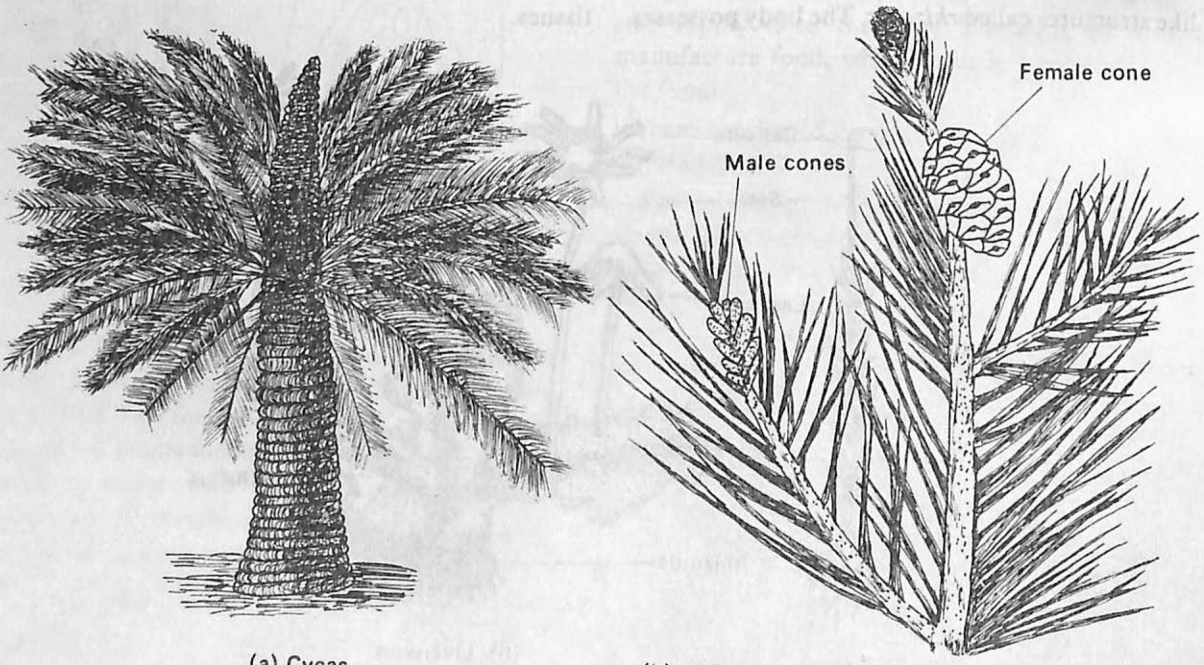


FIG. 6.6 A fern plant



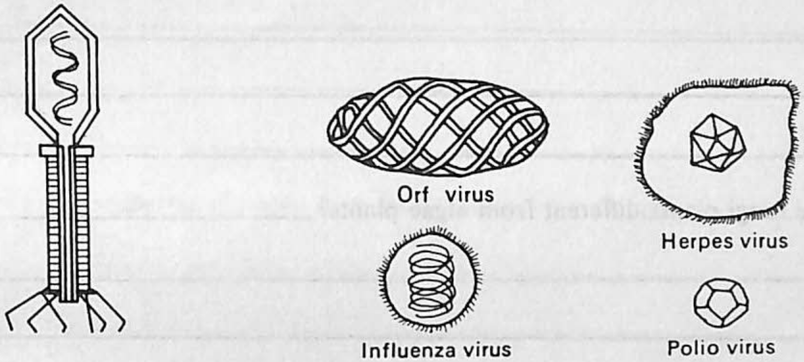
(a) Cycas

(b) Male and female cones in a pine plant

FIG. 6.7

in the same plant (Fig. 6.7b). In majority of these plants, the leaves are needle shaped.

Angiosperms: Angiosperms constitute all flower bearing plants. They can be terrestrial, aquatic or arboreal (living above the ground level or in air) plants. They grow all around us, and many of them are cultivated by man for various uses. Their seeds are enclosed in fruits. The angiosperms are further classified as *monocotyledon* (having seeds with one cotyledon), (e.g. paddy, maize and coconut) and *dicotyledon* (e.g. mustard, pea and sunflower). You can see several angiosperms growing in your garden and in fields.



(a) A virus (b) Disease causing viruses

FIG. 6.8

Among the diversity of living organisms around us, a great many are invisible to the naked eye, because of their small size. All the microscopic organisms are referred as *microbes*. Among them are protozoa, some fungi, bacteria and viruses. Viruses are said to be at the border line of living and non-living organisms. Let us study these in more detail.

Viruses (Fig. 6.8): They are peculiar organisms, sharing the properties of living and non-living objects. They do not have a cellular structure like any living organism, but like a living organism they multiply or reproduce. They are so minute that they can only be seen through an electron microscope.

Viruses cause deadly diseases such as polio, small pox and influenza. Certain diseases of plants, with symptoms such as rolling and wrinkling of leaves are also caused by viruses.

EXERCISES

1. Why is classification of living organisms necessary?

2. What is the branch of biology dealing with classification of living organisms called? ______

3. Name the major phyla of plants. ______

4. What are the characteristic features of thallophytes? ______

5. How are fungi plants different from algae plants? ______

6. What are bacteria? Where are they found? ______

7. How are bacteria (i) useful and (ii) harmful? ______

8. What are bryophytes? Give any two examples. ______

9. In what way are pteridophytes more advanced than thallophytes? ______

10. How are the pteridophytes useful to us?

11. What are the special features of gymnosperm plants? Where do they grow?

12. How are gymnosperms different from angiosperms?

13. What is the main feature of phylum *Spermatophyta*?

14. How are the angiosperm plants further classified?

15. What are viruses? Name the diseases caused by viruses.

7

The Animal Kingdom

Like plants, animals can also be classified into various groups. The two major groups are *vertebrates* and *invertebrates*. Animals such as fish, man and frog have a backbone, also known as the vertebral column, to support their body. They are termed as vertebrate animals. Animals such as earthworm, snail and mosquito have no backbone. They are termed as invertebrate animals.

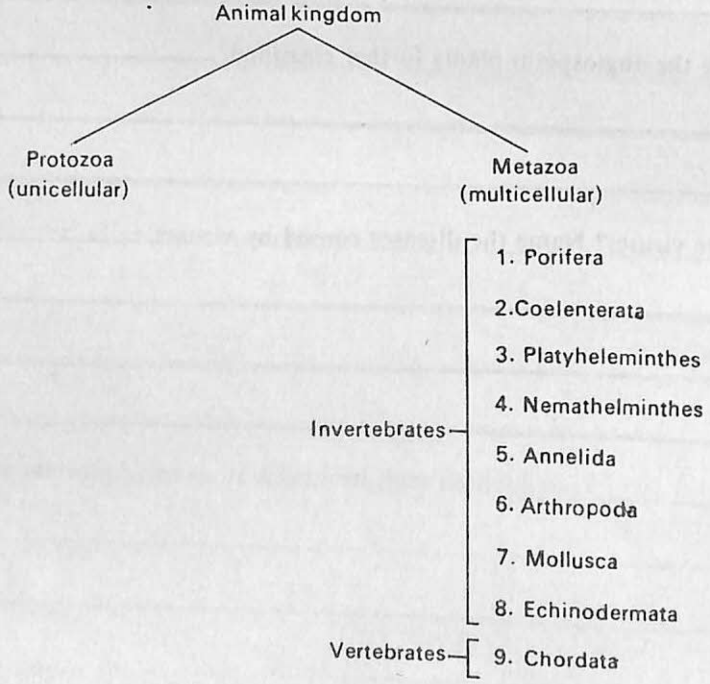
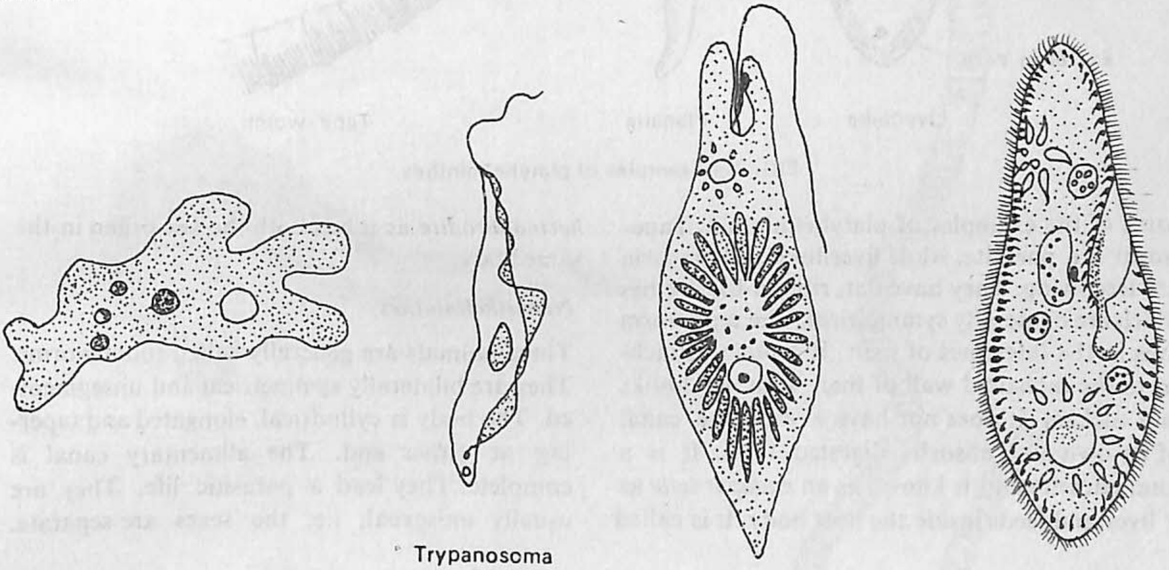


FIG. 7.1 The animal kingdom

Animals can also be divided into two groups known as *protozoa* and *metazoa*, depending on the number of cells that constitute their bodies. The bodies of protozoans consist of single cells. Amoeba and euglena are protozoans. The bodies of metazoans are composed of a number of cells. Cat, man, insects, fish are all metazoans.

Figure 7.1 shows the major phyla of animals under these two subkingdoms. Phyla 1-8 are invertebrates while phylum 9 (chordata) are vertebrates.


Amoeba

Trypanosoma
(Parasitic)

Euglena

Paramoecium

FIG. 7.2 Protozoans

Protozoa

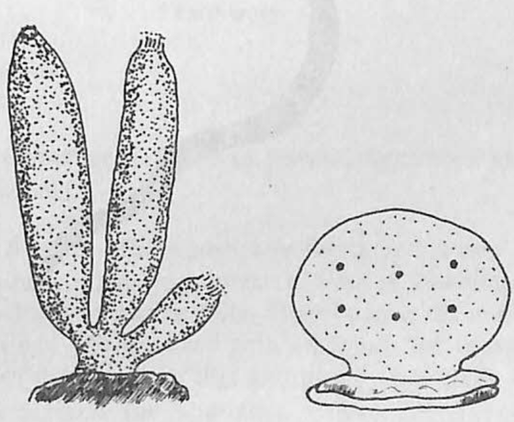
Protozoans are microscopic organisms having only one cell (unicellular). They are mostly aquatic but some of them are found on the soil as well. Some such as plasmodium and entamoeba are parasitic protozoans, whereas others such as paramoecium and amoeba are free living animals (Fig. 7.2). All the life activities are performed in the single cell with the help of cell organelles.

Porefera

The term *porefera* is derived from 'pore'. Members of this phylum have a large number of pores in their bodies. The sponges, sycon, etc. (Fig. 7.3) belong to this group. They are aquatic, living mostly in sea water. They attach themselves to solid substratum and force currents of water through the pores in their bodies. From this water they filter out particles or organic material which serve as their food. They are therefore known as filter feeders. Unlike other animals they do not move in search of food.

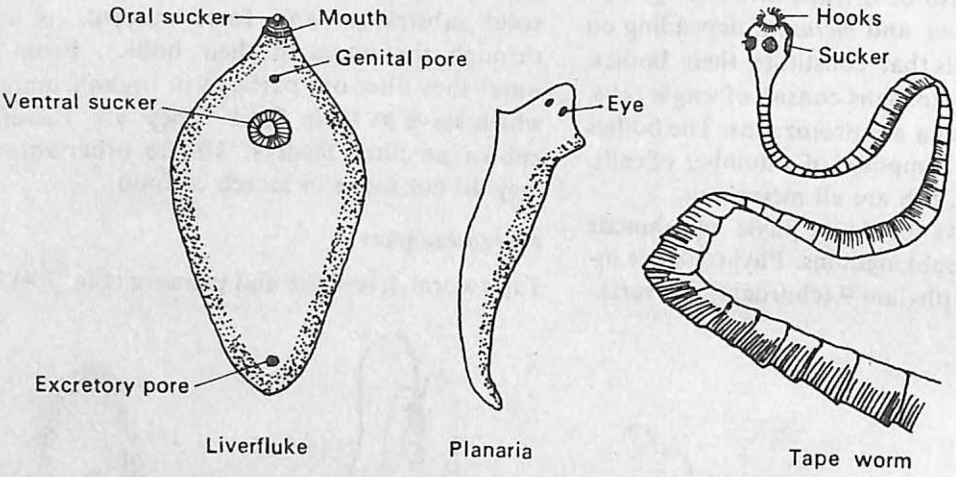
Platyhelminthes

Tape worm, liverfluke and planaria (Fig. 7.4) are


Sycon

Euspongia
(bath sponge)

FIG. 7.3 Animals of phylum Porefera



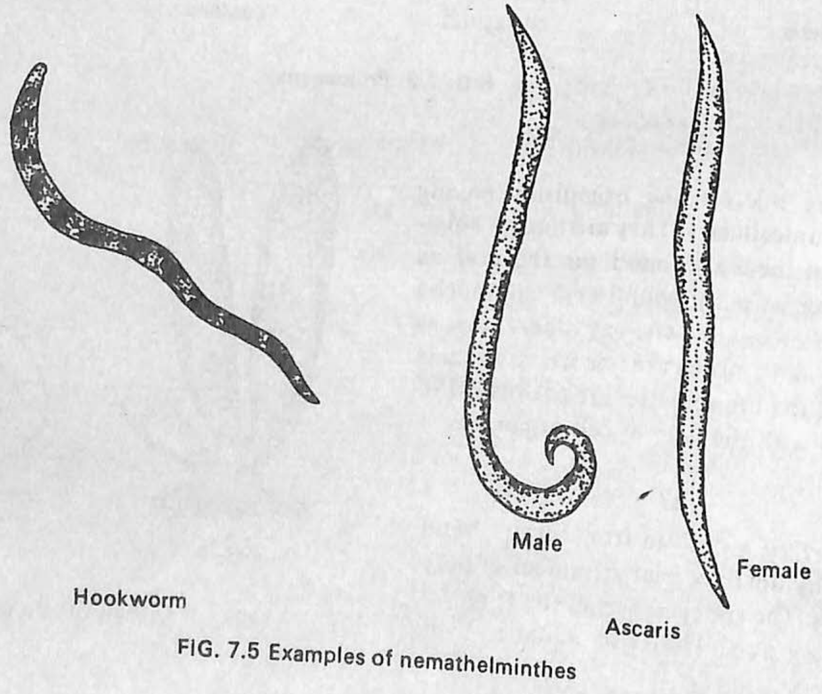
Liverfluke Planaria Tape worm

FIG. 7.4 Examples of platyhelminthes

some of the examples of platyhelminthes. Tapeworm is a parasite, while liverfluke and planaria are free living. They have flat, ribbon-like bodies which are bilaterally symmetrical. The tape worm lives in the intestines of man. It remains attached to the intestinal wall of man with its hooks and suckers. It does not have a digestive canal of its own and absorbs digested food. It is a total parasite and is known as an *endoparasite* as it lives and feeds inside the host body. It is called *hermaphrodite* as it has both the sex organ in the same body.

Nemathelminthes

These animals are generally called roundworms. They are bilaterally symmetrical and unsegmented. The body is cylindrical, elongated and tapering at either end. The alimentary canal is complete. They lead a parasitic life. They are usually unisexual, i.e. the sexes are separate.



Hookworm

Male Female

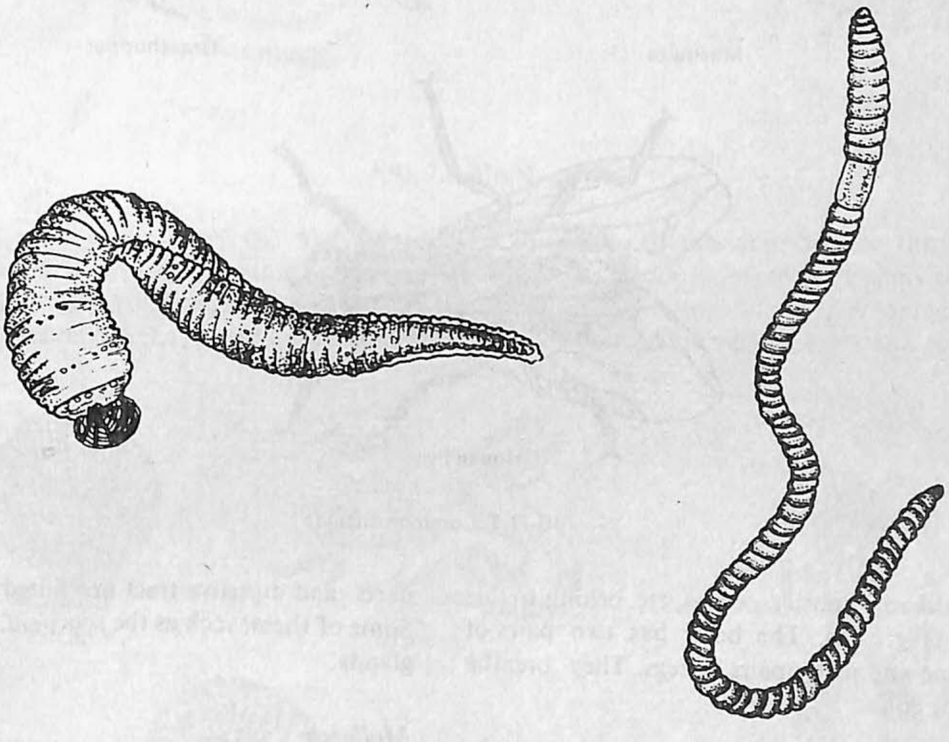
Ascaris

FIG. 7.5 Examples of nemathelminthes

Animals such as hookworm and ascaris belong to this phylum (Fig. 7.5).

Annelida

Earthworm and leeches (Fig. 7.6) are examples of annelids. Their bodies are bilaterally symmetrical. They are segmented worms, i.e. their bodies are divided into segments, externally and internally. The body is covered by a thin and moist cuticle secreted by the epidermis. The alimentary canal is more or less a straight tube starting from the mouth and ending at the anus. Annelids can be bisexual (hermaphrodites) such as earthworms, or unisexual such as leeches. Annelids can be parasitic such as leeches or free living such as earthworms. Leeches suck the blood of humans and animals and are known as *ecto-parasites* (living outside the body of the host). Earthworms help the farmers by loosening and thus ventilating the soil.



Leech

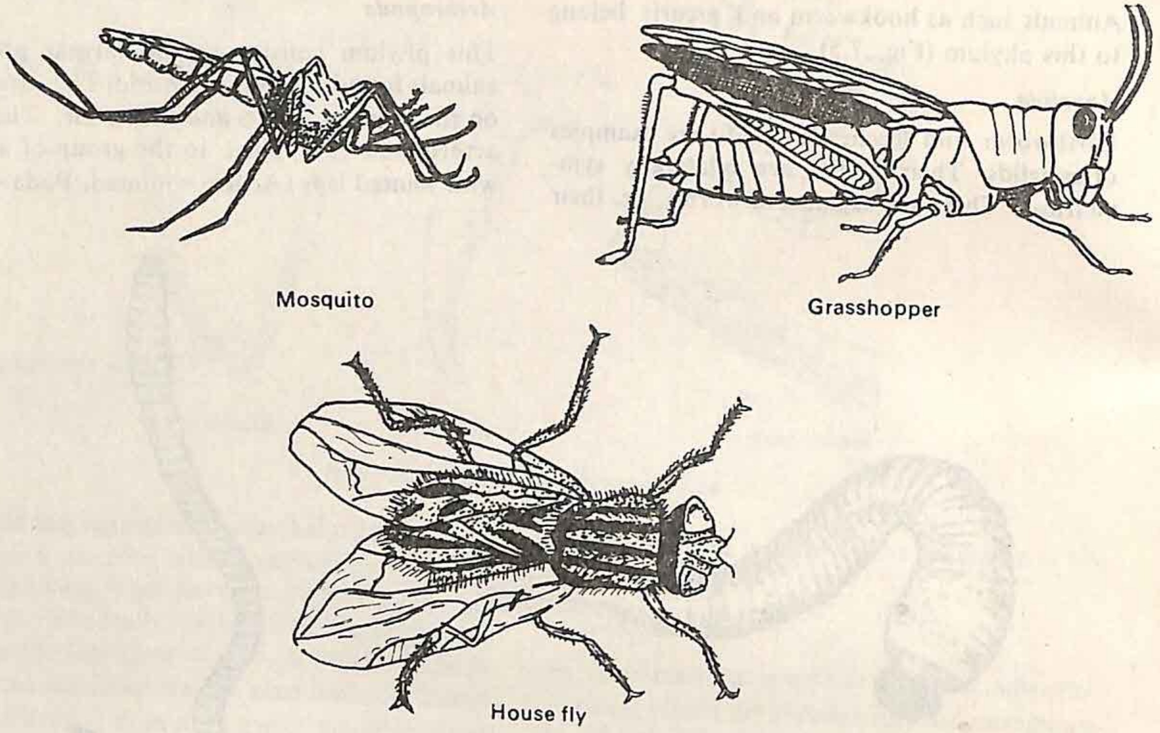
Earthworm

FIG. 7.6 Annelids

Arthropoda

This phylum constitutes the largest group of animals found all over the world. They are found on the land, in water, and in the air. The term arthropoda is applied to the group of animals with jointed legs (Arthro = jointed, Poda = legs). It is further classified as insecta, crustacea and arachnida.

Insecta: This constitutes the largest group of animals inhabiting the earth. 9 out of 10 animals in this world are insects. Their body is distinctly divided into the head with antennae, the thorax with three pairs of legs and usually two pairs of wings, and the abdomen, with no appendages (Fig. 7.7). They breathe through the trachae. A few examples are locusts, wasps, ants and bed bugs. Some insects, such as mosquitoes and lice. are ectoparasites.


Mosquito

Grasshopper

House fly

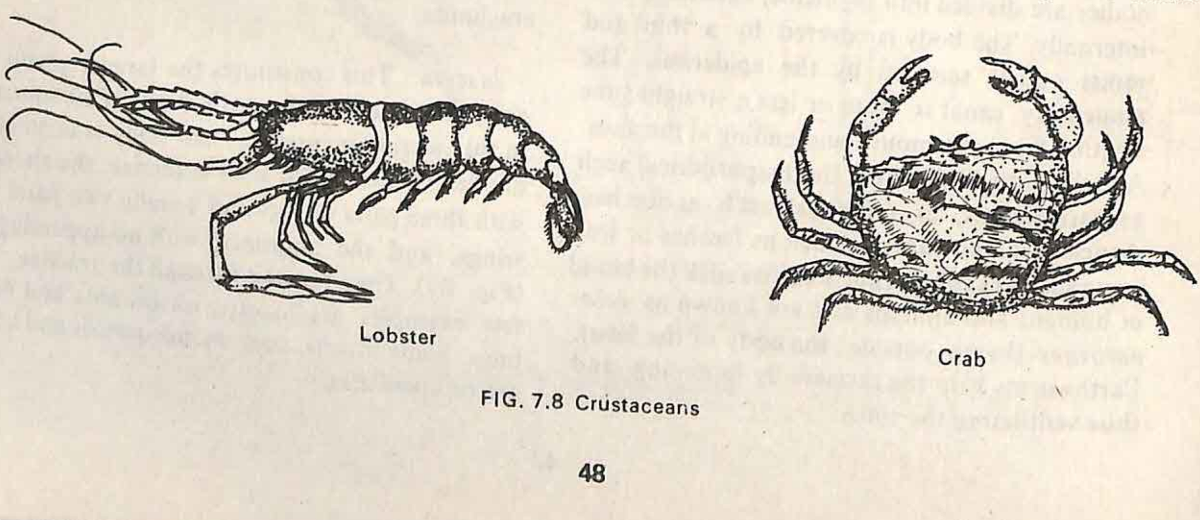
FIG. 7.7 Common insects

Crustacea: Lobsters, crabs, etc. belong to this group (Fig. 7.8). The body has two pairs of antennae and many pairs of legs. They breathe through gills.

Arachnida: The absence of antennae and presence of four pairs of legs distinguish arachnids from crustaceans and insects. Common examples (Fig. 7.9) are spiders, scorpions, mites, etc. They respire by lungs, trachae or gills. The mouth parts and digestive tract are suited for sucking. Some of them, such as the scorpion, have poison glands.

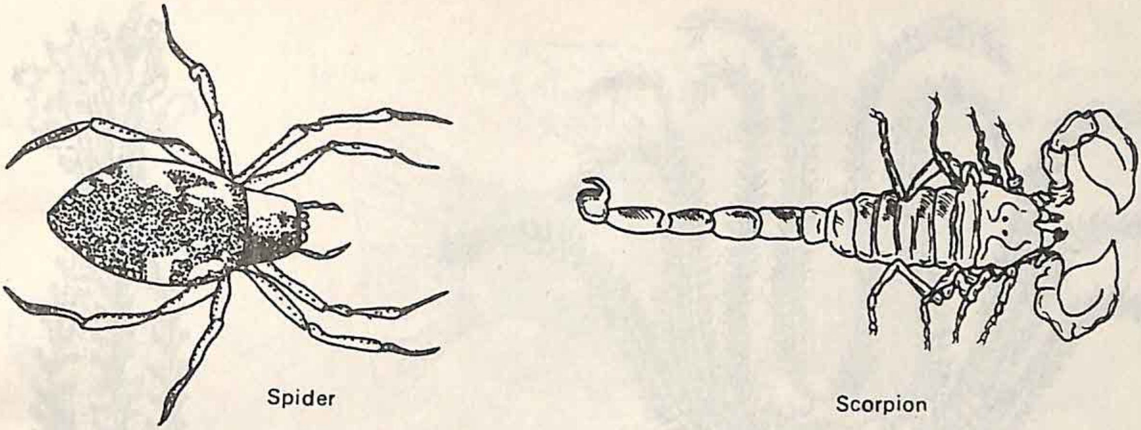
Mollusca

Molluscans (Fig. 7.10) are bilaterally symmetrical, tending to asymmetrical as in snails. They are soft-bodied, unsegmented animals, usually covered by a shell (univalved) or by two shells


Lobster

Crab

FIG. 7.8 Crustaceans

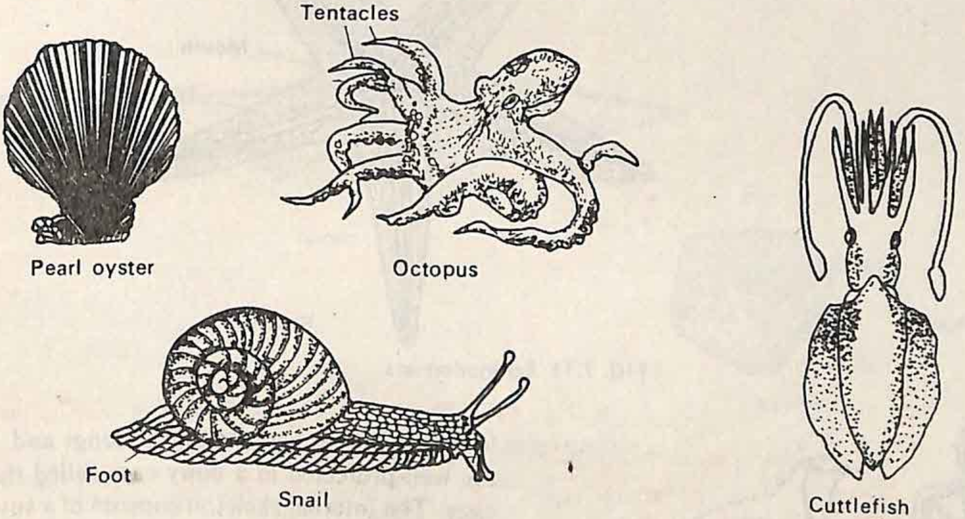


Spider

Scorpion

FIG. 7.9 Arachinda

(bivalved) on either side of the body. Snails are univalved whereas fresh water mussels and pearl oysters are bivalved molluscans. Land molluscans move with the help of a muscular foot and the marine ones by tentacles. They respire through gills. All the molluscans are moisture loving animals. They are found in moist soil as well as in fresh and sea water. Snails and fresh water mussels are found on the land, mostly in gardens. Cuttle fish, octopus, pearl oysters are marine moluscans.



Pearl oyster

Octopus

Snail

Cuttlefish

FIG. 7.10 Molluscans

Echinodermata

These are radially symmetrical animals. All of them live in the sea, and breathe through skin gills. Their body is covered with spiny skin. They have a unique system of *tube feet* for locomotion. However, they are very sluggish and some, such as sea lily, remain stationary. Examples of this phylum are starfish, snake star, brittle star and sea cucumber (Fig. 7.11).

Chordata or Vertebrata

Animals with back bone or vertebral column belong to this group and are called vertebrate animals (Fig. 7.12). Besides the vertebral column their skeletal system consists of cranium (brain case) and paired appendages such as fins or

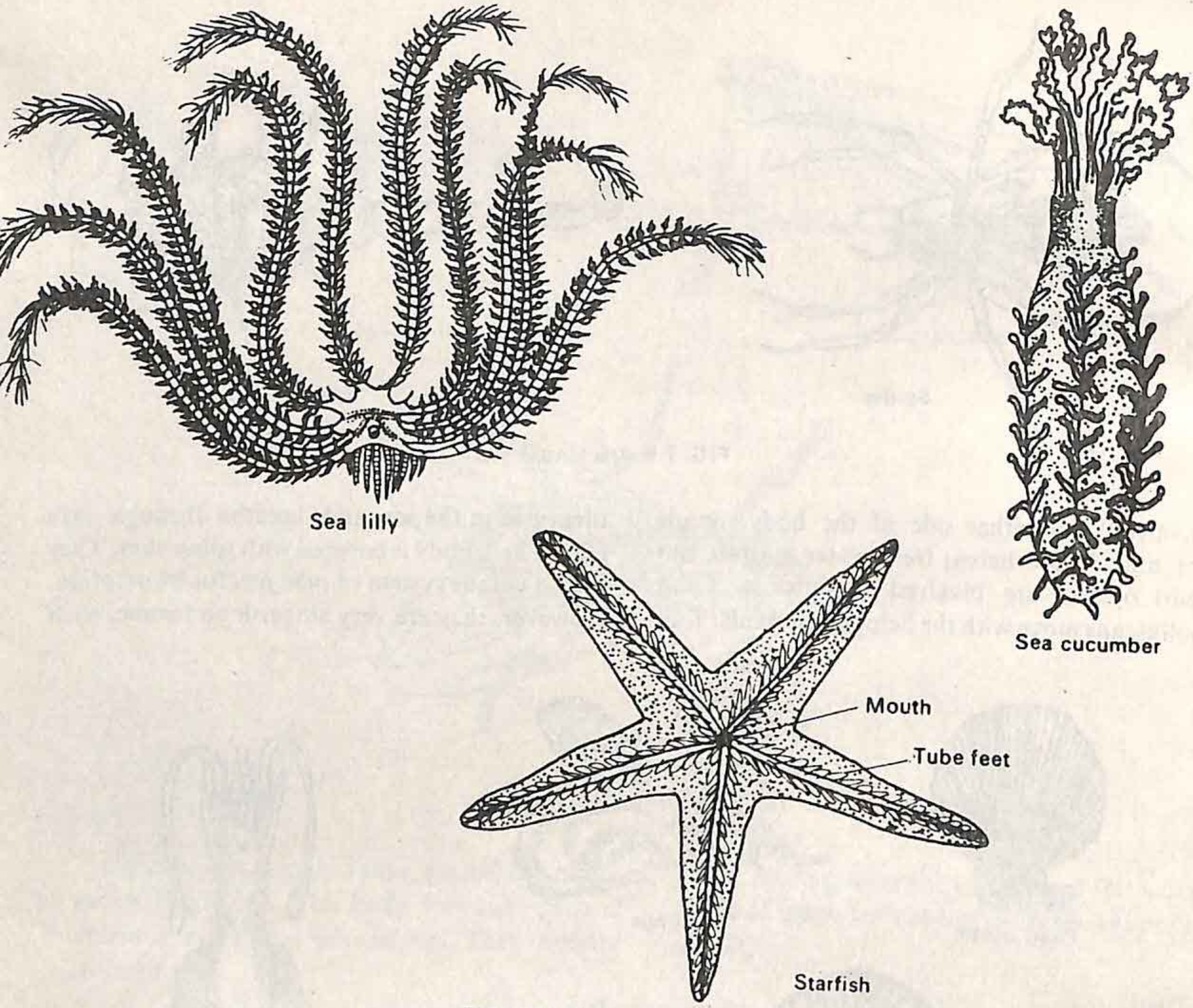


FIG. 7.11 Echinodermata

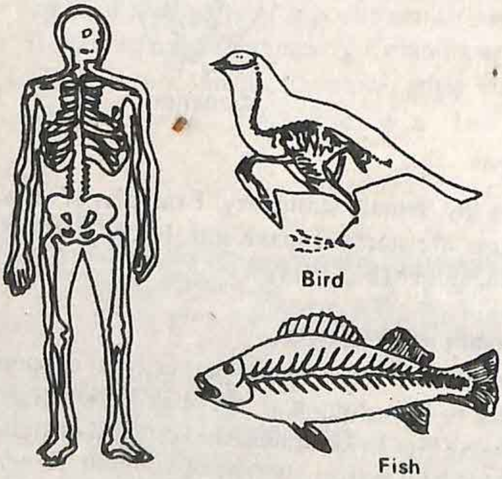


FIG. 7.12 Vertebrates

limbs. In higher vertebrates the lungs and heart are well protected in a bony case called the rib-cage. The internal skeleton consists of a supporting rod called the *notochord*. The systems such as nervous, excretory and endocrine are highly developed in the vertebrate animals.

The chordates are further classified into several classes: *pisces*, *amphibia*, *reptilia*, *aves* and *mammalia*.

Pisces (fishes): These animals are *cold blooded*, i.e. their body temperature is variable, and dependent on the environment. All are aquatic, and breathe through gills. They have two pairs of fins for swimming. Their skin is generally

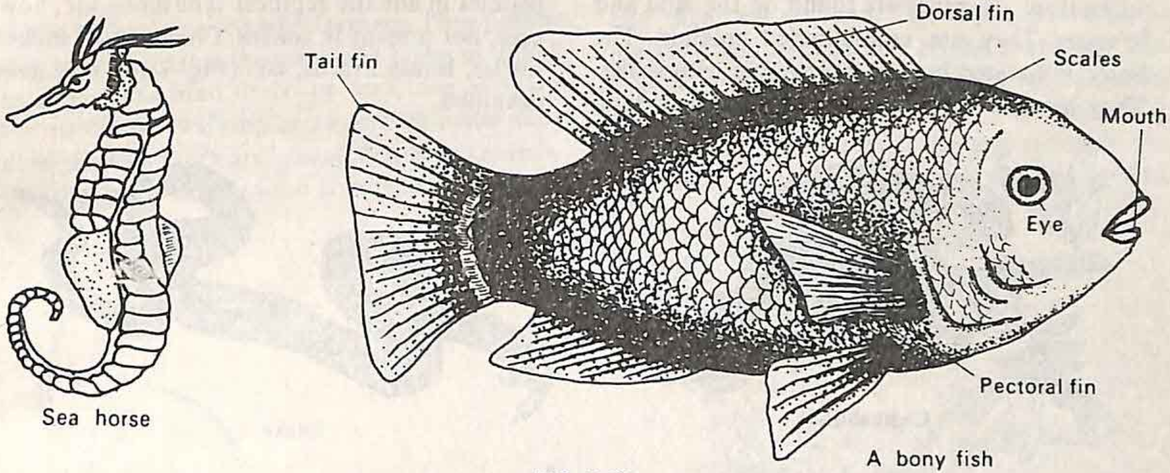


FIG. 7.13

covered with scales. They have a streamlined body which is boat shaped. Fishes can be *bony* or *cartilageous*, depending on whether the chief constituent of their skeleton is bone or cartilage. Sea horse, eel, etc. are bony fishes (Fig. 7.13). Shark, ray fish, etc. are cartilageous (Fig. 7.14).

Amphibia: The members of this class are toad, frog, salamander, etc. (Fig. 7.15). They live in water as well as on land. They are cold-blooded animals. The skin is naked and moist as in frog, sometimes with dry warty skin as in toad. They have two pairs of limbs that help in locomotion.

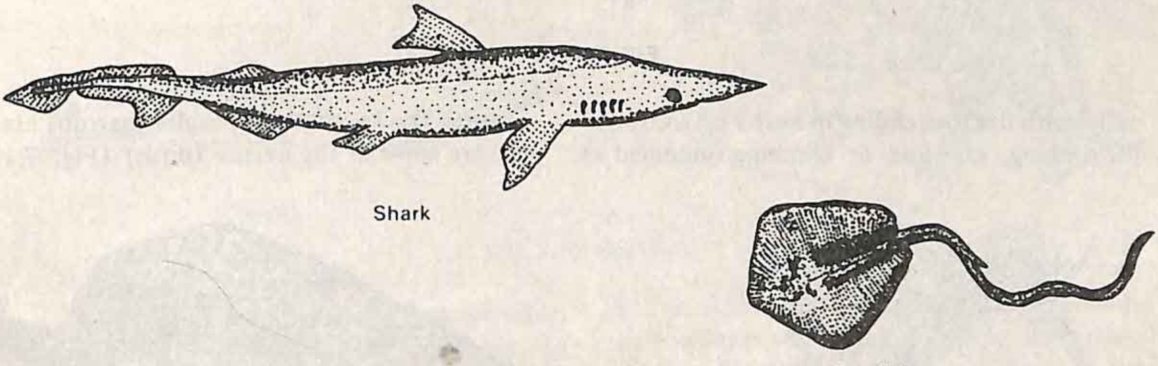


FIG. 7.14 Cartilageous fish

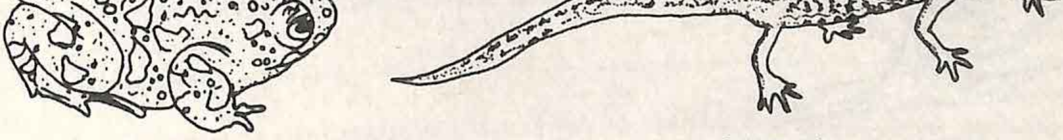
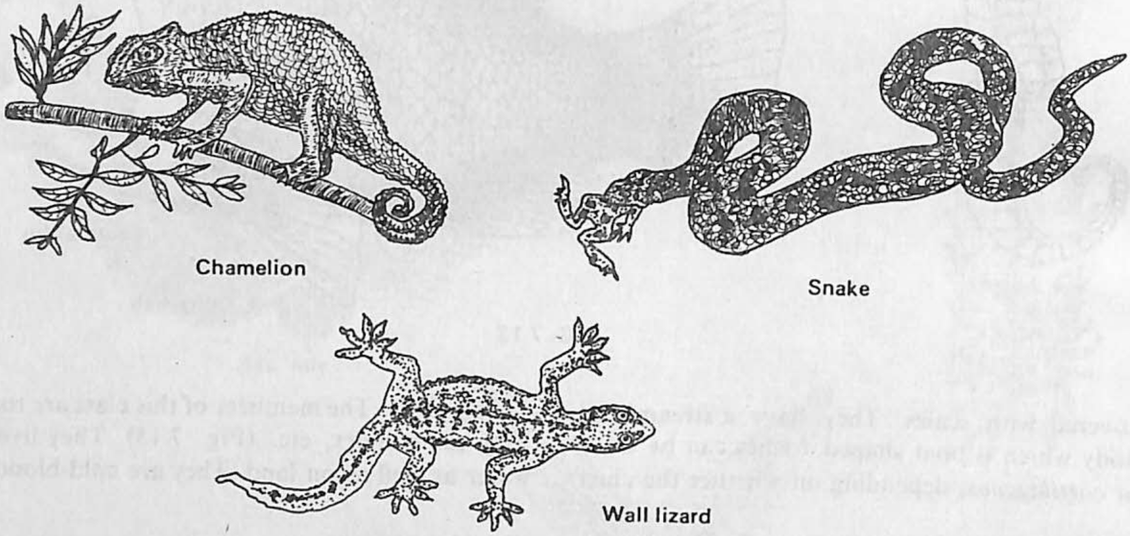


FIG. 7.15 Amphibians

Reptilia: Reptiles are found on the land and in water. They are cold-blooded animals. The body is covered by dry, horny skin with scales. They have two pairs of limbs, each pair typically with five toes ending in horny claws, suited for running, crawling or climbing (modified as paddles in aquatic reptiles). The limbs are, however, not present in snakes. Chamelions, snakes, turtles, house lizards, etc. (Fig. 7.16) are good examples.

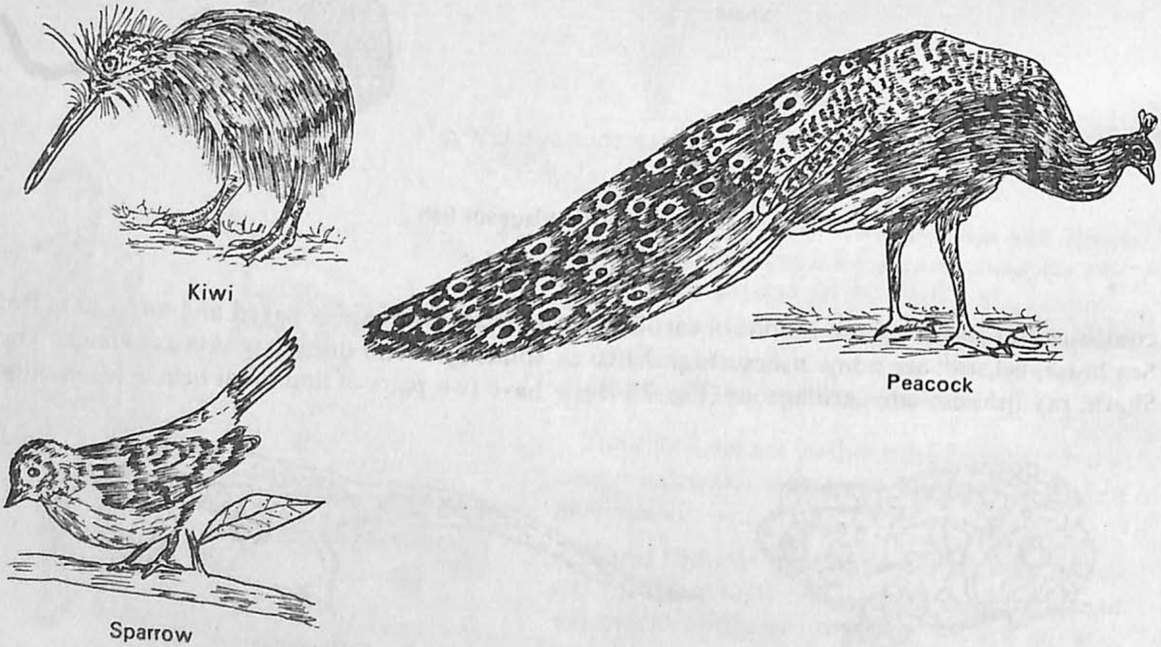

Chamelion

Snake

Wall lizard

FIG. 7.16 Reptiles

Aves: Ducks, sparrows, eagles, parrots, kiwis, etc. are some of the avians (birds) (Fig. 7.17).


Kiwi

Peacock

Sparrow

FIG. 7.17 Birds

Their body is covered with feathers. They possess two pairs of limbs, the forelimbs being modified to wings. The hind limbs or legs, are adapted for perching, walking or swimming (with webs as in ducks). Birds are *warm blooded* animals, i.e. the body temperature is independent of the environmental temperature and is not variable. Bones are hollow and filled with air so that the body remains light and can be easily airborne. They have horny beaks with no teeth.

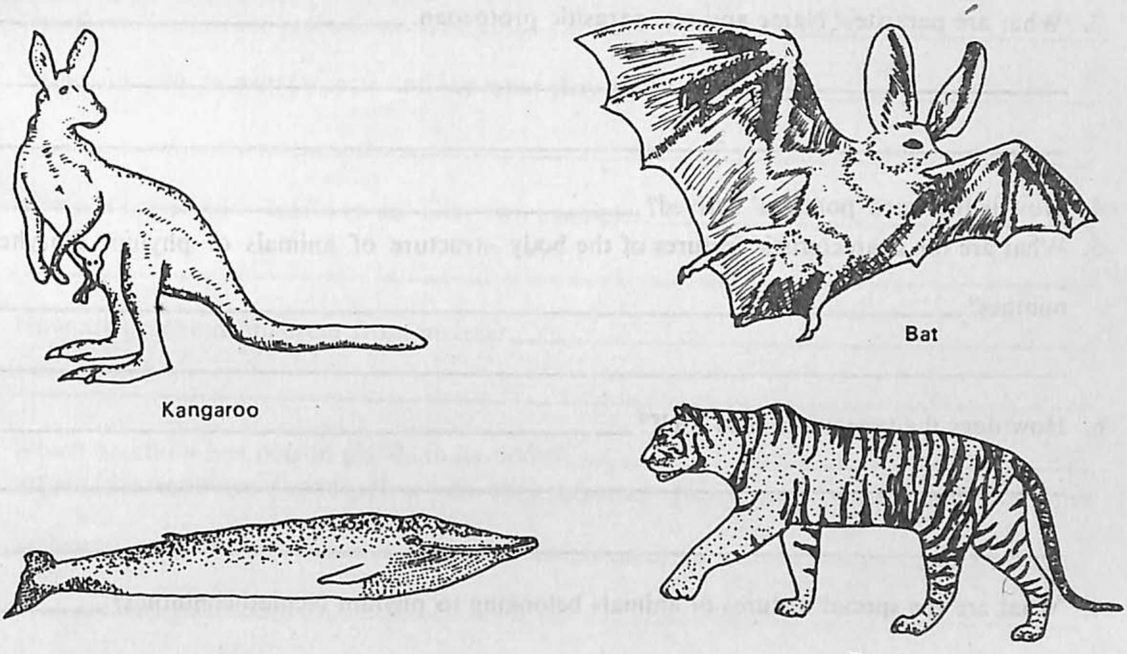


FIG. 7.18 Mammals

Mammalia: Mammals (Fig. 7.18) live in water, land or air. Most mammals such as rats, tigers and men live on land. The whale is an aquatic mammal and the bat is a flying mammal. The skin of mammals is rich in glands such as sweat glands, oil (sebaceous) glands and mammary glands. They suckle their young through the mammary glands. The body is covered by hair or fur. Respiration is done by lungs. They have external ears with pinnae. The eyes have movable eyelids. Mammals possess two pairs of limbs, each with five digits, adapted for flying, climbing, running, walking or swimming.

EXERCISES

1. How are vertebrate animals different from invertebrate animals? ____________________

____

2. List the phyla of invertebrate animals. Give one example for each. ____________________

____

3. What are parasites? Name any one parasitic protozoan.

4. How is the word 'porefera' derived?

5. What are the characteristic features of the body structure of animals of phylum Platyhelminthes?

6. How does the tape worm feed itself?

7. What are the special features of animals belonging to phylum Nemathelminthes?

8. What do you mean by hermaphrodite animals? Give any two examples.

9. Name any two annelids and give the special features of their external body structure.

10. Name any annelid that sucks human blood. What are such parasites known as?

11. What is the main feature of arthropods? Give the subdivisions of phylum Arthropoda.

12. Name any two parasitic insects and say what they feed on?

13. How are crustaceans useful to us? Give two examples.

14. How are arachnids different from insects?

15. Which arachnid has poison glands in its body?

16. Where are molluscs found? How do they breathe? Name two marine and two land molluscs.

17. Give some examples of animals of phylum Echinodermata. Discuss locomotion in these animals.

18. What is the most important feature of chordates?

19. What are the subdivisions of phylum Chordata?

20. What do you mean by 'cold-blooded' and 'warm-blooded' animals? Give one example of each.

21. Why do fishes generally have a streamlined boat-shaped body?

22. Name any two amphibians.

23. Where do reptiles live? Give any two examples.

24. What is the special feature of the bones of birds? Why is this so?

25. What are animals which suckle their young called?

26. Give one example each of an aquatic mammal, a flying mammal and a terrestrial mammal.

Which type of mammal are you?

27. Draw diagrams of (a) Amoeba (b) Tapeworm (c) Starfish.

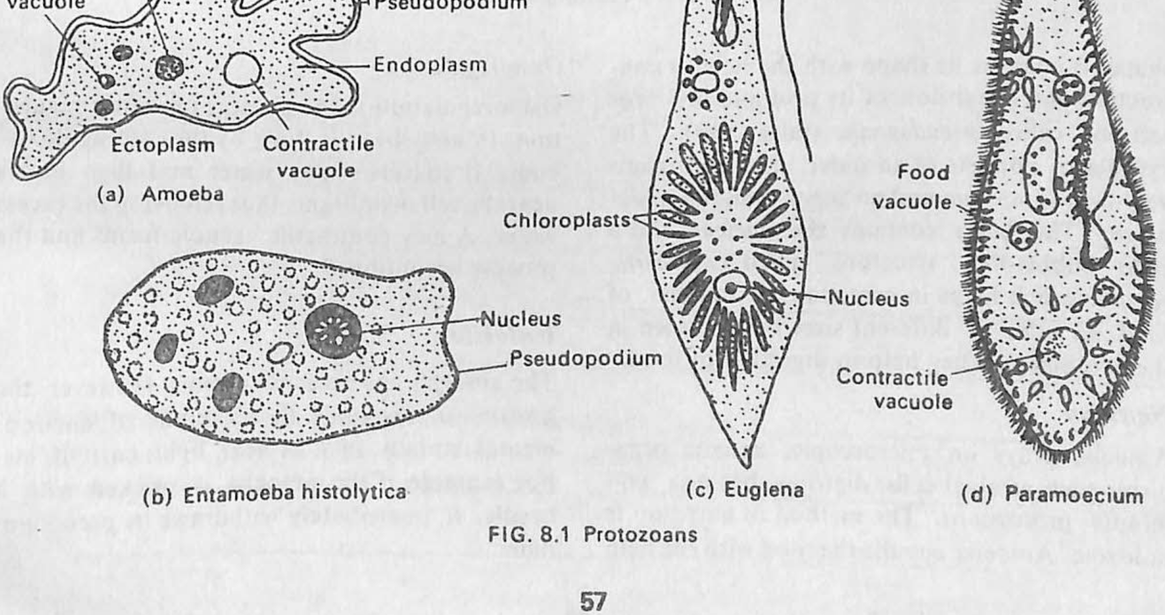
8

Unicellular Animals

Protozoans are the most primitive microscopic animals. They are acellular or non-cellular animals whose bodies are not differentiated into cells, but into specialised parts or organelles. The shape of the body varies. It may be irregular (amoeba), elongated (paramoecium) or spindle shaped.

Protozoans exist everywhere on the land, in fresh water and in sea water, and also as external and internal parasites of plants and animals. Plasmodium and entamoeba are good examples of parasitic protozoa.

The mode of nutrition may be holozoic (animal like), holophytic (plant like), parasitic



(a) Amoeba

(b) Entamoeba histolytica

(c) Euglena

(d) Paramoecium

FIG. 8.1 Protozoans

(depending on other living organisms) or saprozoic (feeding an dead organisms).

Locomotion is carried out by pseudopodia in amoeba, flagella in euglena, and cilia in paramoecium. Respiration and excretion are carried on by the general surface of the cell. Reproduction is by asexual as well as sexual methods.

Amoeba

Amoeba was first discovered by Rosel von Rosenl in 1775. It is commonly found in fresh water ponds and streams. It is a microscopic, free living animal (Fig. 8.1a) performing all its life activities by its single cell.

Structure

Amoeba is a unicellular animal of irregular shape. It changes its shape with the help of contraction and expansion of its protoplasmic projections called *pseudopodia* (false feet). The cytoplasm consists of an outer, clear and relatively firm *ectoplasm* and an inner granular *endoplasm*. The latter contains the *nucleus*, and a clear bubble-like structure called *contractile vacuole* which helps in excretion. A number of *food vacuoles* of different sizes may be seen in the cytoplasm. They help in digestion of food.

Nutrition

Amoeba preys on microscopic, aquatic organisms such as algal cells, diatoms, bacteria and minute protozoans. The method of nutrition is holozoic. Amoeba engulfs the food with the help of its pseudopodia (Fig. 8.2), forming a food vacuole. Digestion takes place within the cell and the digested food is assimilated. The undigested food is thrown out from any point. The digestion in amoeba is therefore said to be *intracellular* (inside the cell).

Respiration

Amoeba absorbs oxygen dissolved in water through the cell membrane. This oxygen is used to oxidise the food and release energy. The carbon dioxide produced during oxidation is released through the cell membrane.

Locomotion

The pseudopodia help in the mobility of the amoeba. The extension of pseudopodia in one direction and their withdrawal from other directions make the animal move.

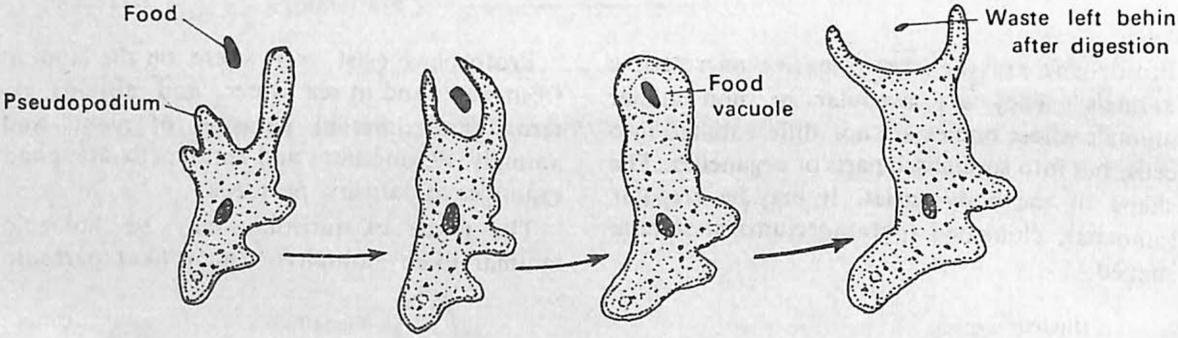


FIG. 8.2 Feeding in amoeba

Osmoregulation

Osmoregulation is the process of water regulation. In amoeba it is done by the contractile vacuole. It collects excess water and then bursts near the cell membrane, thus removing the excess water. A new contractile vacuole forms and the process is continued.

Irritability

The amoeba has no sense organs. However the protoplasm responds to all kinds of environmental stimuli such as heat, light, current, etc. For example, if the amoeba is pricked with a needle, it immediately withdraws its pseudopodium.

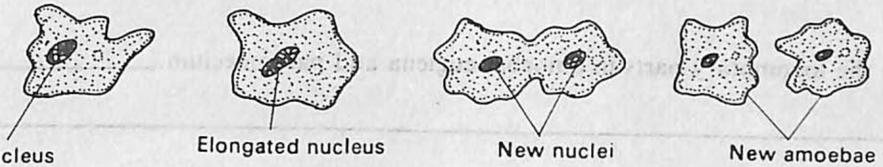


FIG. 8.3 Binary fission in amoeba

Reproduction

Binary fission: During favourable conditions, when amoeba attains maturity and its maximum size, it withdraws its pseudopodia and becomes spherical. The nucleus elongates and becomes constricted in the centre. At the same time the protoplasm becomes dumb-bell shaped and eventually breaks into two parts, each containing a nucleus. This process of producing two daughter cells from the parent amoeba, is called *binary fission* (Fig. 8.3).

Multiple fission: This takes place during unfavourable conditions, for e.g. in a dry pond. The amoeba assumes a rounded shape by withdrawing the pseudopodia and secretes a thin protective covering called a *cyst*. It remains inactive in this state till conditions are again favourable. In this passive state the nucleus sometimes divides into many daughter nuclei and each daughter nucleus gets surrounded by cytoplasm. These small cells are known as *spores*. When conditions are favourable again, the cyst breaks and each spore produces a new amoeba (Fig. 8.4).

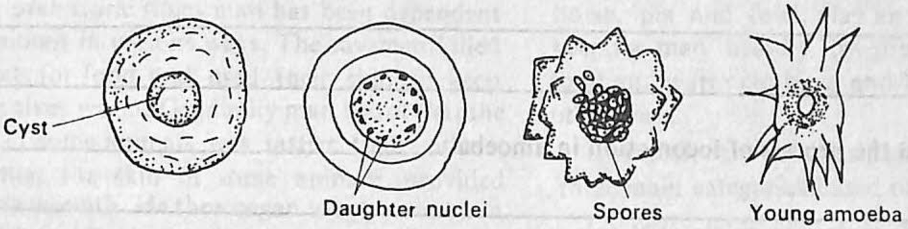


FIG. 8.4 Multiple fission in amoeba

EXERCISES

1. What is the characteristic feature of a protozoan? ____________________

____

2. How is amoeba different from paramoecium? ____________________

____

3. What are the modes of nutrition in protozoans? ____________________

____

____

4. Name the locomotary parts in amoeba, euglena and paramoecium.

5. What do you understand by 'intracellular' digestion in amoeba?

6. How is water regulation carried out in amoeba? What is the process known as?

7. Explain 'irritability' in amoeba.

8. Explain the process of locomotion in amoeba.

9. What is binary fission? When does it occur in amoeba?

10. When does multiple fission occur in amoeba?

9

Useful Animals

Since prehistoric times man has been dependent on animals in various ways. The cavemen killed animals for food and used their skin to keep themselves warm. Gradually man learnt that the flesh of some animals was tastier than others, and that the skin of some animals provided greater warmth. He thus began to rely on certain animals for food and clothing.

Soon man discovered that some animals could be tamed and domesticated. To begin with, his companion was the dog, who helped him to hunt during the day and showed him the way to his cave at night. Even today, the dog is the most faithful friend of man. Slowly the early man began to keep useful wild animals such as sheep, goat and pig in captivity and even started domesticating them.

In the process of domestication, he developed certain methods to take care of their feeding, to protect them from disease, and to even get animals of better breed (hybridization). The study of these aspects of domesticated animals is called *animal husbandry*.

Domesticated Animals and Their Importance

Livestock, such as cattle, sheep, goat, camel, horse, pig and fowl, play an important role in keeping man healthy by providing nutritious food and warm clothing, and by helping him in other ways.

Livestock can be classified as follows, into three main categories based on their utility.

(a) *Milk giving animals* such as cows, buffaloes and goats provide us milk. Milk is a complete, natural diet. Other food items we get from milk are butter, ghee, curds, cheese, etc.

(b) *Meat and egg providing animals:* The flesh or meat of goats, sheep, pigs, ducks, fowls, etc., is rich in proteins and fats. Poultry animals such as ducks and hens lay eggs, which are very nutritious.

(c) *Draught animals:* Animals such as bullocks, buffaloes, horses, donkeys, mules, etc. are working animals. They are used for various purposes such as ploughing the fields and transporting man and materials from one place to another.

Besides providing food, some livestock, such as sheep, buffaloes and cows are useful for their skin. The fur of sheep is used to prepare wool, from which most of the warm clothing we wear, is made. The skin or hide of cows and buffaloes is treated with chemicals and processed into fine leather. We all know how useful leather is to us. Several items of daily use such as shoes, purses and gloves are made of leather.

Cattle

The common cattle we find in rural and urban areas are cows and buffaloes. They are herbivorous (plant eating) animals. To obtain a high milk yield from them, it is essential to give them a balanced diet. They should be fed with a mixture of grasses with alfalfa (a kind of legume) and clover (which are rich in proteins), oil cakes and other foods containing minerals and vitamins. Adequate quantities of food should be given to them at fixed intervals.

It is necessary to provide them with well ventilated sheds and to protect them from heat and cold. The sheds should be kept clean and care should be taken to see that they are free from disease-causing germs. The animals should be washed periodically to clean the urine and excreta from their bodies.

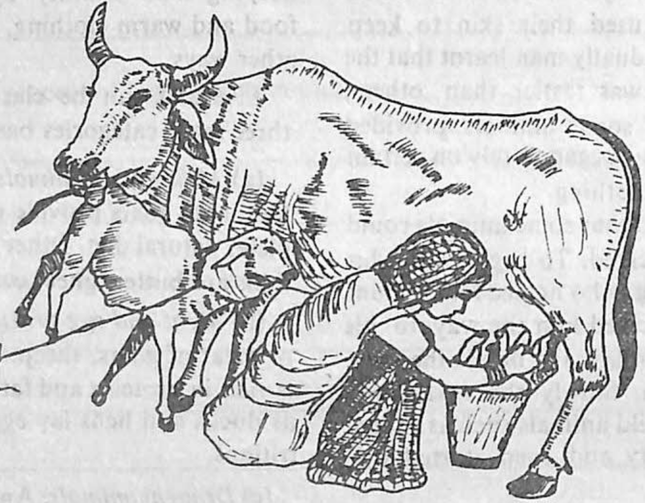


FIG. 9.1 A woman milking a cow in an Indian village.

It is also necessary to see that the cattle maintain their health. Timely precautions should be taken to prevent diseases. The symptoms of any disease must immediately be looked into, and medical help taken from veterinary hospitals. A diseased animal should be separated from the others. One of the diseases the cattle suffer from is the *foot and mouth disease*. It is a contagious disease in which the animal loses its appetite, develops soreness in the mouth, and salivates more. Sometimes the saliva is seen hanging from the mouth.

Milking (Fig. 9.1) should be done twice a day, morning and evening, at fixed timings. The udder should be cleaned with water to make it free from urine and dung. The animals are stimulated by the hands or machines before milking is done.

Sheep and Goat

Sheep and goat are domesticated for their wool (fur), meat and hide. They move in groups called *flocks*. They survive better in dry lands with less rainfall. They are herbivorous. Their main food consists of chaff and seeds.

Their shelter should be kept dry and well ventilated. Warm and closed sheds should be avoided as they sweat in winter also and can catch cold very easily.

Sheep are important for their wool. The removal or shaving of the wool is called *shearing*. Before shearing is done, the animal body is cleaned of dung and dust particles.

Sheep and goat often suffer from pneumonia. Their nose gets blocked and they have difficulty in breathing. The treatment consists of providing inhalation with eucalyptus oil added to a bucket of boiling water. This is very similar to the treatment given to us for common cold.

Pig

The management of pigs is known as *piggery*. Pigs are domesticated for their meat and hide. Because of a small alimentary canal, pigs cannot digest bulky and fibrous food. Dry food is therefore given to them in dry troughs. Sometimes water is added to the food. Their food consists of potatoes, barley or linseed cake. They are fed thrice a day. Each animals is fed separately, otherwise the weak ones are deprived of food by the stronger ones.

The sheds of pigs should be strong, otherwise they may pull them down. The sheds are made up of straw, bamboo or wood. They should be big enough to be fitted with feeding troughs. The floor should be of wood.

A disease called the *diamond disease* is very common in pigs. The animals suffering from it become lethargic and develop constipation. The disease is contagious and is spread by the urine and dung of the diseased animals. Vaccines are used to control this disease.

Some varieties of pigs provide good pork. The pork of stray pigs should be avoided as this can lead to severe stomach ailments.

Poultry

Keeping a group of useful birds such as hens and cocks, which provide meat and eggs is called poultry. Male and female in the domestic fowl can be distinguished by certain external features. The male (cock) has a long plumed tail, and a comb and wattles on the head (Fig. 9.2).

These birds are fed with grains, green food and limestone. Limestone helps in digestion of food and in the formation of egg shells. Poultry birds are fed in troughs or their food may be spread on the ground. They need to take in a lot of water for the production of eggs.

The shelter for these birds should provide safety and comfort. It should be covered with wires, so that the birds do not fly or run away. The floor should be covered with straw. The shelter should be cleaned and excreta and food material thrown all over should be cleared.

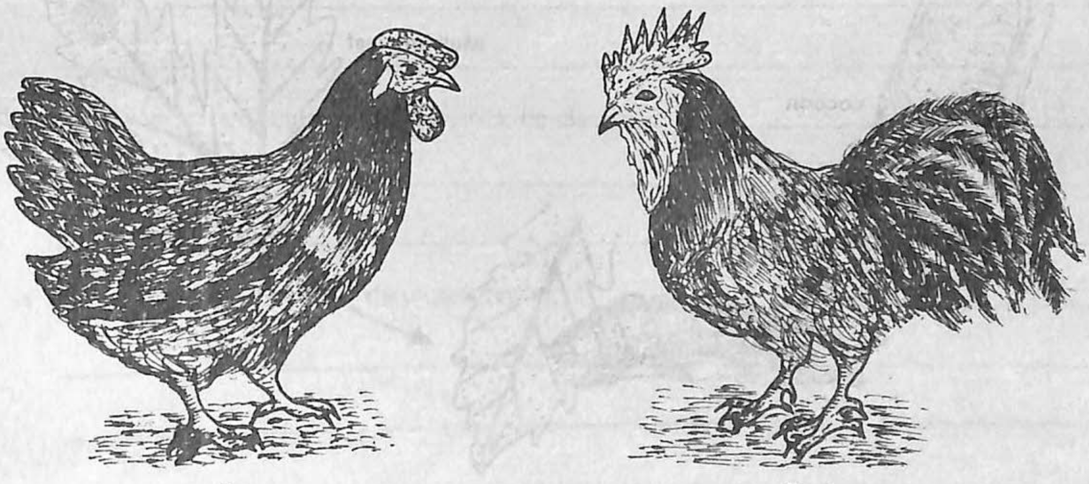
The eggs these birds lay are of great food value to us, as they contain a lot of proteins. They are hatched by the hen, who provides the warmth necessary for hatching by sitting on the eggs.

Insects

Among the insects that are beneficial to us are the honeybee and the silk moth. Rearing of honeybees is called *apiculture* and that of the silk moths is called *sericulture*.

HONEY BEE

Honey is produced by honey bees. They inhabit



Hen

Cock

FIG. 9.2

trees and build their homes, called *beehives*, on the branches (Fig. 9.3). These have many units or chambers called *combs*. The bees collect nectar from flowers and convert it into honey. This is stored in the beehives.

Honey consists of water, sugar, minerals and enzymes. The enzymes present help in food digestion. Honey is also used as an antiseptic.

The rearing of honey bees has now become a popular occupation among people.

FIG. 9.3 A beehive

SILK MOTH

Silk moth is a very useful insect. It produces the silk yarn. Let us understand its life cycle (Fig. 9.4) to know at what stage it produces the yarn from its body.

Eggs: Soon after fertilisation, each female lays about 200 eggs in clusters on the leaves of mulberry trees. The females cover the eggs by a gelatinous secretion which sticks them to the leaves.

Caterpillar or larva : The silk worm that hatches from an egg is known as a caterpillar. It is a tiny creature, about 6 mm long. It at once

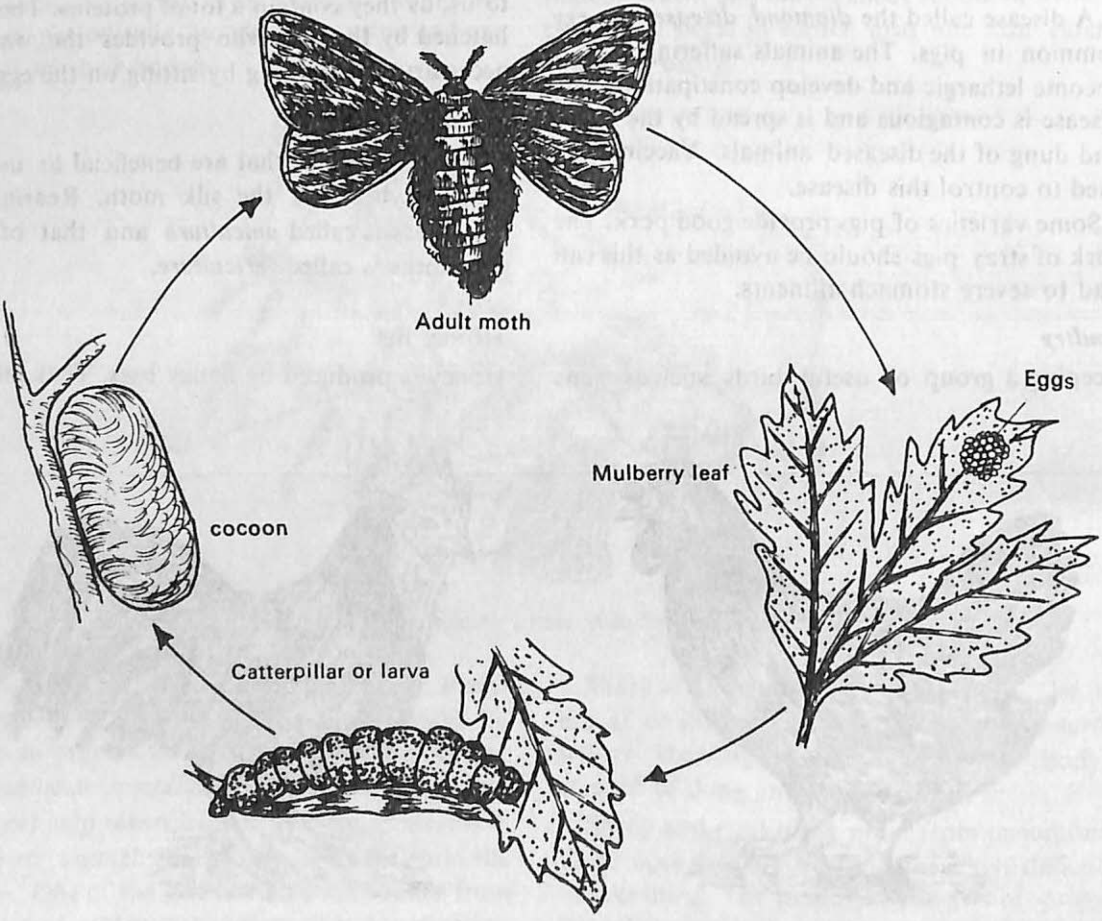


FIG. 9.4 Life cycle of a silk worm

starts to feed greedily upon the mulberry leaves and grows quickly. After four or five days, it stops feeding and becomes inactive. Now the older skin bursts and the caterpillar, slightly bigger in size than the earlier one, emerges out with a new skin. This process is known as *moulting*. It resumes eating and grows until the skin is again cast off after a week. The larva repeats this process four times. It takes 45 days since the time of hatching to get matured.

Pupa or chrysalis: The caterpillar now stops feeding and returns to a corner among the leaves. It begins to secrete a sticky fluid from its salivary glands. This sticky substance turns into a fine, long thread of silk in the air. The thread becomes wrapped around the body of the pupa forming a case called a *cocoon*. A single pupa produces nearly 300 metres of silk thread this way.

For obtaining silk for commercial use, the cocoons are treated with hot water or placed in a hot oven to kill the pupa inside. The silk is unwound from the cocoons and twisted into threads. A few cocoons are kept as *seeds* for the next generation of moths. 454 g of silk is obtained from about 25,000 cocoons. About 23 million kg of silk is produced every year in the world.

Imago: The pupa finally metamorphosises into a baby insect or imago. It secretes an alkaline fluid to moisten one end of the cocoon, and escapes by forcing its way out of the softened silk. Soon after emergence, the silk moths mate, lay eggs and die.

In addition to the useful animals we have discussed so far, there are many others such as fish, prawn, etc. that provide us with food full of protein. Corals and shells of sea molluscs are used for decoration. The pearl from pearl oysters is used in jewellery and is very valuable.

EXERCISES

1. What is animal husbandry? ____________________

2. In which main categories can livestock be classified? ____________________

3. What are hides? How are they useful to us? ____________________

4. What kind of food is given to cattle?

5. Name the common diseases among

(a) cattle

(b) pigs

(c) sheep

6. From where do we get wool?

7. Why should warm and closed sheds be provided to sheep in winter?

8. What is shearing?

9. What food is given to pigs in piggeries?

10. What is poultry?

11. What does the food of poultry birds consist of? How does limestone in their feed help them?

12. Name some insects that are useful to us.

13. What are beehives? Where do you find them?

14. What does honey consist of? How is it useful to us?

15. What is

(a) apiculture?

(b) sericulture?

16. Where do silk moths lay their eggs and why?

17. What is moulting?

18. Name the different stages in the life cycle of a silk moth. At what stage does it weave the silk thread around it?

19. What is a cocoon?

20. Briefly explain how the silk fibre is obtained from the pupa of the insect, for commercial use.

10

Useful Plants

The most remarkable fact concerning useful plants is their antiquity. History tells us how man cared for plants from early times and how he started cultivating them for his basic needs of food, shelter and clothing. As his knowledge of plants increased he learnt to derive more and more benefits from them. Thus plants became a part of his life. Without them life for man, or for any animal, is impossible.

Let us understand how plants can be useful to us for our basic necessities of food, shelter and clothing.

Food Plants

These can be classified as *cereals*, *pulses* or *legumes*, *vegetables* and *fruits*.

Cereals

Cereals such as rice, wheat, maize, barley and oats constitute the major food of man. They are the best sources of carbohydrates, and also provide considerable amount of proteins and fats.

PADDY

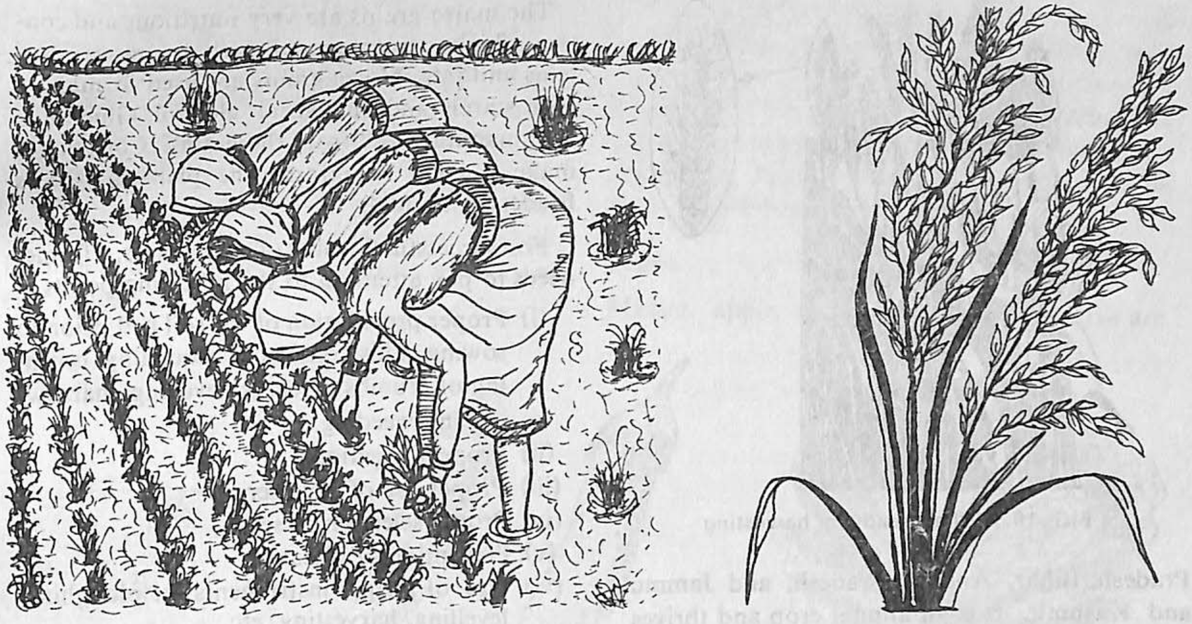
Paddy is grown in India during the monsoon season and is known as a *Kharif* crop. It takes 3-4 months to mature. It is the main staple food in India. It is a monocotyledonous plant.

The fields for paddy cultivation are ploughed and enriched with farm yard manure or fertilisers. Sprouted seed grains or seedlings are grown in special nursery beds. They are then transplanted in the fields in rows (Fig. 10.1a). The young plants are covered with water and the water is kept in circulation. After some time water is drained from the fields and they are left to dry. They are again irrigated to full. When the crop matures, it appears golden yellow in colour. It is harvested in Indian villages with the help of a *sickle* (Fig. 10.2).

The dried plants are *thrashed* to separate the grains with husks from the chaff or hay. When the husk is removed from paddy seeds, we get rice grains. These rice grains are dried and stored.

Rice is the staple food in India. It is mostly cultivated in the Ganges valley in the north and in low lying coastal areas in the southern states. The crop grows best in damp soil, where the fields are water-logged and can be flooded.

Research in paddy cultivation has yielded many improved varieties. These give better yields,



(a) Transplantation of paddy plants

(b) Matured plants ready for harvesting

FIG. 10.1

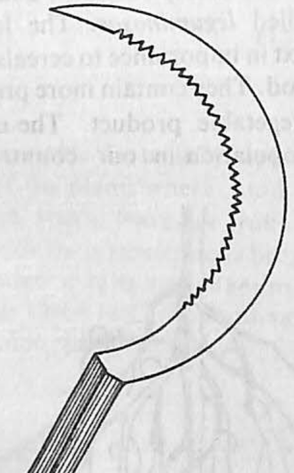


FIG. 10.2 A sickle used for harvesting of paddy

are more disease resistant and can withstand adverse climatic conditions. The yield of paddy, as well as other cereals, is also being increased by mechanization in tilling and harvesting. The Indian farmer is now using power tillers, tractors and harvestors for these purposes.

WHEAT

Wheat also forms an important staple food in India. The crop is grown during the winter season, and is said to be a *Rabi* crop. Like paddy, wheat plants are also monocotyledonous. The wheat growing areas in our country are the Gangetic plains having alluvial soil, and the black soil area of peninsular India.

Wheat (Fig. 10.3) is a seasonal crop. The sowing season is October to November. It may be sown by hand or by machines. It takes a fortnight for the first leaves to appear.

The crop matures and is ready for harvesting in four to six months after sowing. Cutting is similar to that of paddy. Thrashing is generally done by bullocks or by machines. After thrashing the wheat grains are *winnowed* and sifted, and then stored.

MAIZE

This crop (Fig. 10.4) was introduced into our country from tropical America in the beginning of the 17th century. It is grown as a food crop mostly in Uttar Pradesh, Punjab, Madhya

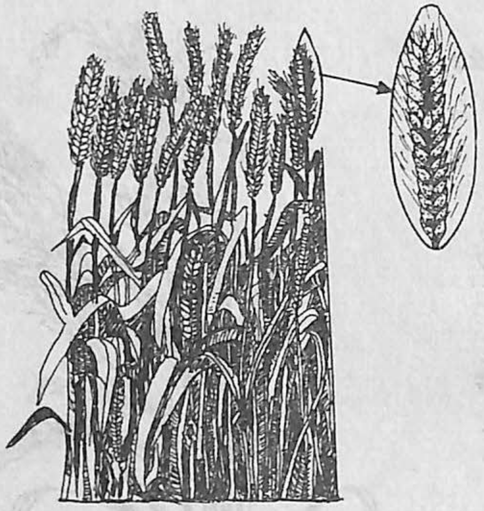


FIG. 10.3 Wheat ready for harvesting

Pradesh, Bihar, Andhra Pradesh, and Jammu and Kashmir. It is an annual crop and thrives best in fertile, well irrigated soil.

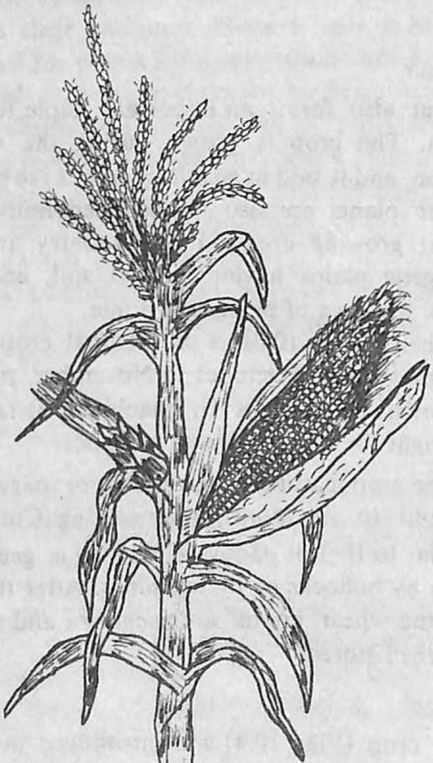


FIG. 10.4 A maize plant

The maize grains are very nutritious and contain a high percentage of carbohydrates, proteins and fats. Maize grains are used in making corn-starch and industrial alcohol. Glucose is also manufactured from the grains. Corn flakes make a good breakfast. The plant is used as fodder for animals.

For successful farming of crop plants, a farmer needs to pay attention to the following points.

- (i) Proper preparation of the soil bed prior to sowing. This consists of ploughing, crushing of crumbs or clods, levelling, harrowing and weeding.
- (ii) Proper irrigation.
- (iii) Proper use of fertilisers.
- (iv) Proper selection of seeds.
- (v) Prevention of diseases.
- (vi) Use of proper instruments for ploughing, levelling, harvesting, etc.

Pulses or Legumes

These plants are dicotyledonous, and belong to a family called *leguminosae*. The legumes or pulses are next in importance to cereals as sources of human food. They contain more proteins than any other vegetable product. The majority of vegetarian population in our country depends

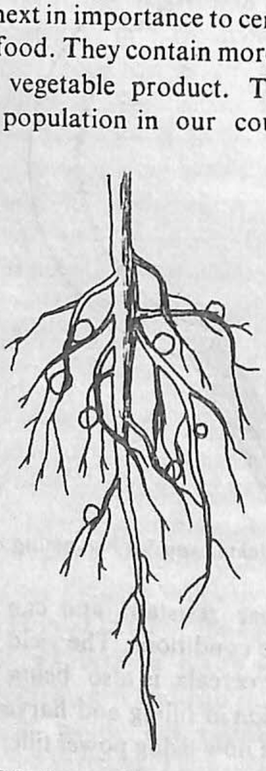


FIG. 10.5 Roots of legume with nodules

on pulses, commonly known as *dals*, for their protein requirements.

The high protein content of pulses is related to the presence of legumes with nodules (Fig. 10.5) containing nitrogen-fixing bacteria in the roots.

The important pulses consumed by Indians are black gram (*urad*), green gram (*moong*), lentil (*masur*), Bengal gram (*channa*), *arhar*, and cow beans.

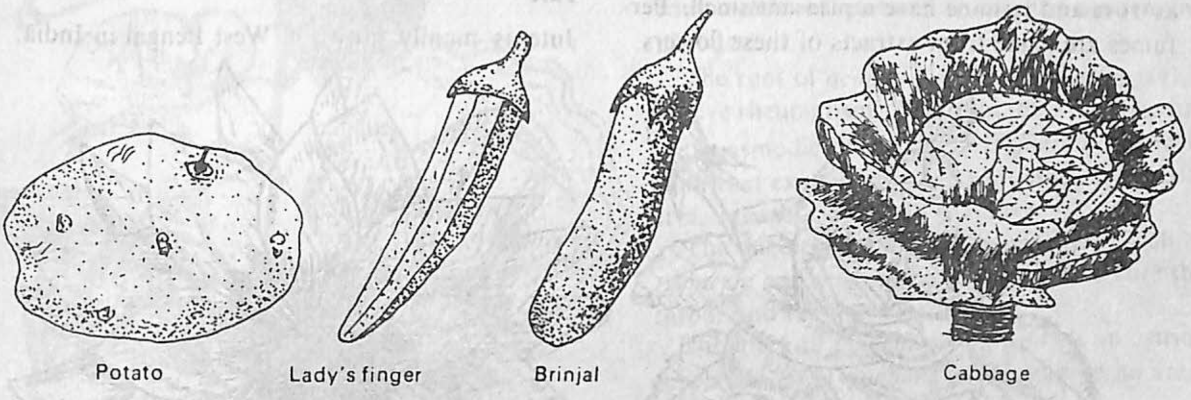

Potato
Lady's finger
Brinjal
Cabbage

FIG. 10.6 Some common vegetables

Vegetables

The term vegetable is usually applied to any edible part of the plant, where food is stored, such as roots, stems, leaves or fruits. The food value of vegetables is tremendous because of the presence of mineral salts and vitamins. Many of them can be eaten raw (the food value is destroyed by prolonged cooking).

Vegetables can be categorised as *leafy vegetables* such as spinach and mint; *starchy vegetables* such as potato and sweet potato; and *juicy vegetables* such as tomato and pumpkin. Other common vegetables used in Indian homes are brinjal, lady's finger, chillies, gourds of all types, and bittergourd (Fig. 10.6).

Fruits

Mango, apple, orange, banana and guava are the most common fruits in our country (Fig. 10.7). Like vegetables, they also provide vitamins and mineral nutrients.

Other food plants include the following.

Sugarcane whose juice is used to make sugar.

Spices and condiments such as turmeric, pepper, cardamom, and vanilla, which are used to flavour food.

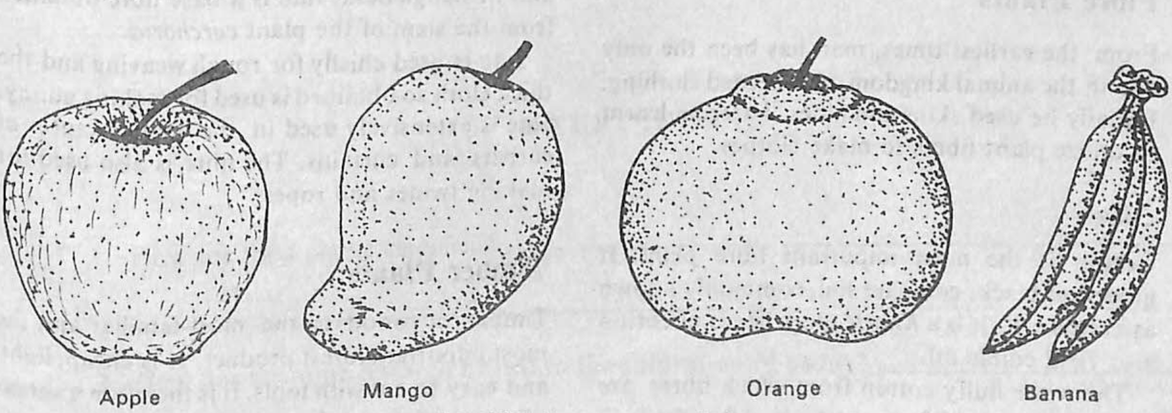

Apple
Mango
Orange
Banana

FIG. 10.7 Some common fruits

Beverages such as tea, coffee and cocoa.

Oil seeds such as groundnut and mustard which yield edible oils.

Ornamental Plants

Ornamental plants, especially plants bearing flowers, are grown mainly for their beauty (Fig. 10.8). The main ornamental plants are roses, bougainvillas, ferns, crotons, dhalias, chrysanthemums and tulips. Some flowers such as rose and jasmine have a pleasant smell. Perfumes are made from extracts of these flowers.

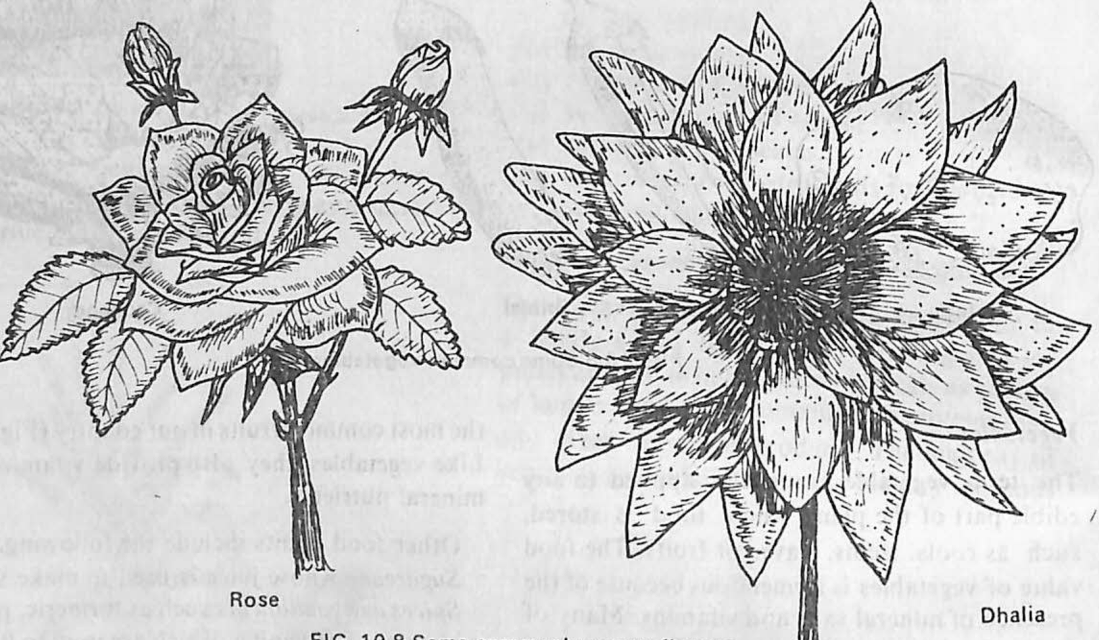


FIG. 10.8 Some commonly grown flowers

Fibre Plants

From the earliest times, man has been the only one in the animal kingdom who needed clothing. Initially he used skins and hides. Later he learnt to utilize plant fibres to make clothes.

Cotton

Cotton is the most important fibre plant. It grows on black, compact soil, commonly known as *cotton soil*. It is a *Kharif* crop. Seeds of cotton also yield edible oil.

The white fluffy cotton from which fibres are spun, is obtained from the fruit. After the fruit matures, it bursts to form cotton *balls* (Fig. 10.9) which can be picked by hand. Cotton should be picked only when the balls are fully mature, fully open and the floss has puffed up on exposure to the sun.

Cotton fibres are woven into cloth (textiles), yarn fabrics, sheets, towels, etc. Unspun cotton is used in mattresses, pads, and upholstries. Sterilised absorbent cotton is used in medicine and surgery for cleaning and dressing wounds.

Jute

Jute is mainly grown in West Bengal in India, and in Bangladesh. Jute is a base fibre obtained from the stem of the plant *corchorus*.

Jute is used chiefly for rough weaving and the thick cloth so obtained is used for making gunny. Jute is extensively used in the manufacture of carpets and curtains. The fibre is also used for making twines and ropes.

Timber Plants

Timber or wood is the most familiar and the most important forest product. It is cheap, light, and easy to cut with tools. It is therefore a versatile raw material for construction of houses,

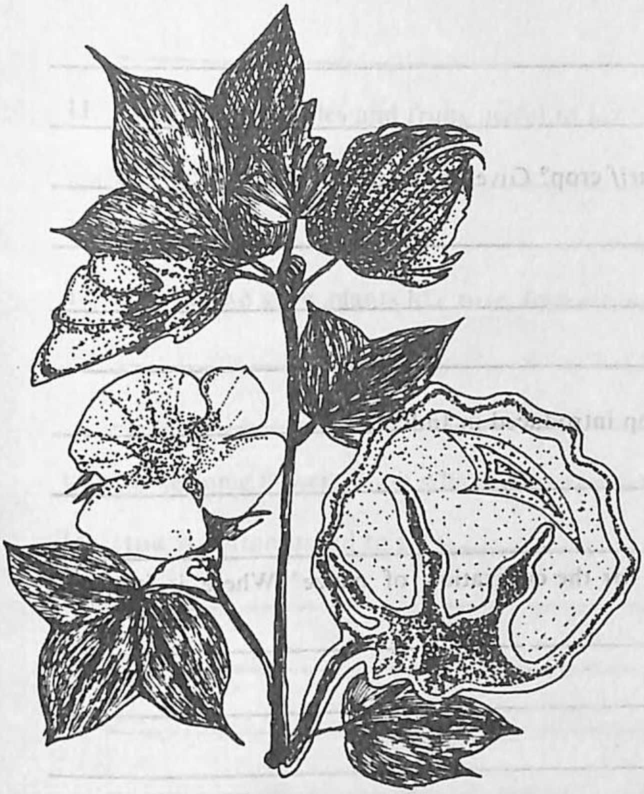


FIG. 10.9 Cotton plant showing a ball of cotton

furniture, sports goods, ships, railway sleepers and various other products.

The principal timber trees of India are *teak*, *sal*, *walnut* and *pine*. Other important timber plants are *rosewood*, *pinewood* and *mahogany*.

Wood is the xylem part of the plant, and is present in all plants. However, commercially useful wood can only be obtained from plants that have lived for a number of years.

Medicinal Plants

The medicinal value of plants is due to the presence of some chemical substances in the plant tissues, that produce a definite physiological action on the human body. The most important of these substances are the *alkaloids*, which are compounds of carbon, hydrogen, oxygen and nitrogen.

The root of *aconite* is used to make drugs that relieve rheumatism. The root of *belladona* has antispasmodic properties. *Asafoetida*, the resin gum that exudes from the root stock is a sedative, antispasmodic and digestive.

The medicinal effects of some stems such as *turmeric* and *mangoginger* are used to cure the throat and the digestive system.

The bark of *cinnamon* (*dalchini*) is an astringent and that of *cinchona* yields quinine, an antimalarial drug.

Leaves of *tulsi*, *neem*, *betel peeper* (*pan*) are well known for their medicinal values. The most modern life saving drugs, the antibiotics such as penicillin, are extracted from fungi. The fungus *penicillium* yields penicillin.

In this chapter, you have learnt the various ways in which plants are useful to mankind. It is your duty, therefore, to care for and protect them, whether they are wild or cultivated.

EXERCISES

1. How are food plants classified? ______________________________

____

2. How has scientific research helped in the cultivation of paddy? ______________________________

____

3. What do you mean by *Rabi* crop and *Kharif* crop? Give one example of each.

4. From where and when was the maize crop introduced in India?

5. What are the essential conditions needed for the cultivation of maize? Where is it grown mostly in India?

6. What kind of nutrients are present in maize?

7. Name some pulses you eat.

8. How do you explain the high protein content of pulses?

9. What do you mean by the term vegetable?

10. How can vegetables be categorized? Give one example of each.

11. How are vegetables and fruits useful to us?

12. Why do we grow plants like rose, fern etc. in our gardens?

13. Name some flowers from which we make perfumes.

14. How is cotton useful to us?

15. How is jute useful to us?

16. Where is jute popularly grown in India?

17. Name any four medicinal plants and say which part of the plant is used for medicinal purposes.

18. What are timber plants? Name any three of the important timber plants grown in India.

19 Which part of a tree is used as wood?

20. Why do you think so much importance is being given nowadays to growing of plants and trees?

21. Draw diagrams of (a) a paddy plant (b) a wheat plant (c) a maize plant.

11

Flower and Its Parts

The flower is the most attractive part of a flowering plant, popularly enjoyed for its beauty and fragrance. It is a part of the shoot, specially modified for reproduction. The essential reproductive parts of a flower are the *stamens* and the *carpels*, which are protected by *sepals* and *petals*. The multicoloured petals and sometimes the sepals attract insects to help in pollination.

Parts of a Flower

A typical flower consists of four sets of floral parts or whorls, arranged on the *thalamus* (Fig. 11.1).

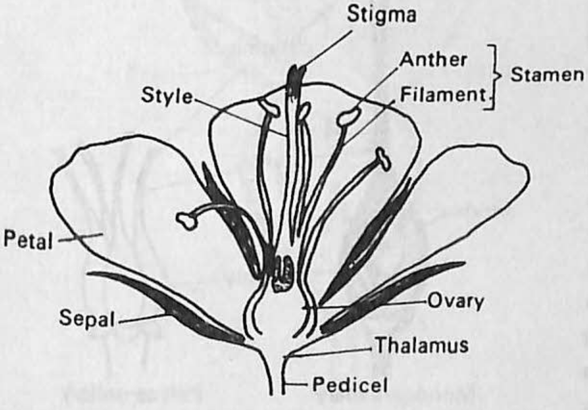


FIG. 11.1 Parts of a flower

THALAMUS

All the floral whorls are placed on a platform called the thalamus. It is a continuation of the floral stalk or pedicel in most flowers. In some flowers it bears nectar glands and in some it helps in seed dispersal.

CALYX

The outermost whorl in a flower is the calyx which consists of a number of *sepals*. Its function is to protect the flower. The sepals are usually green but in some flowers they are coloured like petals. Such sepals are known as *petaloids*. The sepals fall off in some flowers after fertilisation as in mustard. In others such as brinjal and tomato they persist even after fruit formation. Such calyx are called *persistent calyx*.

In flowers such as gulmohar, the sepals are free from each other and are known as *polysepalous*. In flowers such as petunia or datura the sepals are fused and form a tube. The fused sepals are called *gamosepalous*.

COROLLA

This is the inner whorl of the flower and is made up of *petals*, usually bright in colour. Some flowers such as jasmine and rose emit a sweet odour. Some such as salvia and caesalpinia have nectar glands which secrete sweet nectar. The bright colours, odour and nectar attract the insects that help in pollination.

In some flowers such as those of custard apple the petals are green in colour. Such petals are known as *sepaloid*. Like sepals, petals may also be *polypetalous* or *gamopetalous*.

GYNOECIUM

This is the innermost whorl of a flower. It constitutes the female reproductive organ of the flower. It is made up of one or more *carpels* (Fig. 11.3). If the gynoecium (or pistil) has one carpel it is known as *monocarpellary*, as in leguminous plants (e.g. pea). If it has many carpels it is known as *polycarpellary*, as in rose and lotus.

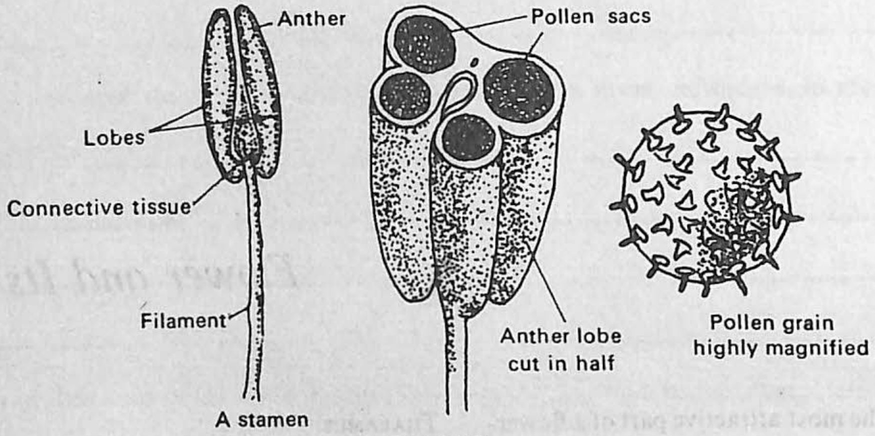


FIG. 11.2

When the colour of the calyx and corolla is the same, as in wheat and maize flowers, the whorls are known as *perianth*.

ANDROECIUM

This is the third floral whorl and is the male reproductive part in a flower. It is made up of one or more *stamens*. Each stamen consists of two parts—*filament* and *anther* (Fig. 11.2).

The stamens may be united to the petals, as in nerium or to the pistil as in china rose. In some flowers, such as brinjal and chillies, the filaments of the stamens are attached to the petals, and anthers remain free. Such arrangement of stamens is called *epipetalous*. When the filaments are attached to the perianth the arrangement is called *epiphyllon* as in tuberose.

The anther consists of two lobes which are united by a connective tissue (Fig. 11.2). Each lobe has two pollen sacs which are filled with pollen grains. The pollen grains are minute in size and look like dust particles. They contain the male reproductive cells.

A typical carpel consists of *ovary*, *style* and *stigma*. The swollen part at the base of the flower is the ovary. It contains one or more little round or oval egg-like bodies called *ovules* which change into seeds after fertilisation. The part of the ovary bearing ovules is called *placenta*. Each ovule contains the female reproductive cell or *ovum* (female gamete). The slender structure

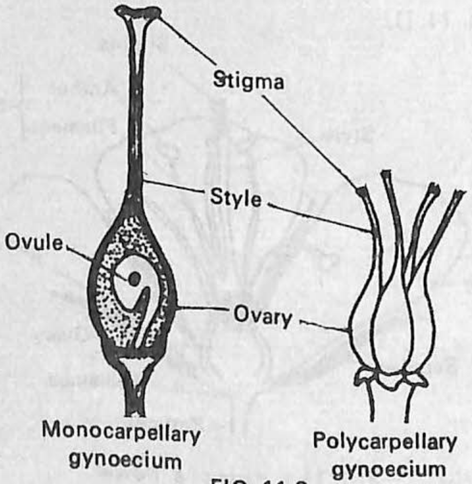


FIG. 11.3

connecting the ovary to the stigma is the style. It provides a passage for the pollen grains to reach the ovule. The style ends in a lobed or round part known as stigma. The surface of the stigma may be sticky, rough, hairy or papillose so that it can easily catch the pollen grains. In the absence of the style, the stigma is situated at the apex of the ovary as in lotus. Such stigmas are called *sessile*.

Variations in Flowers

If all the floral parts—sepals, petals, pistil and stamen are present in a flower, it is said to be a *complete flower* (Fig. 11.4). Examples are gulmohar and petunia.

In some flowers, one or more floral parts may be missing. Such flowers are called *incomplete flowers* (Fig. 11.5) for example, cucurbeta flower.

Flowers such as gulmohar have both the sexual parts—stamen and pistil. Such flowers are called *bisexual flowers* (Fig. 11.4). In some flowers such as cucumber and pumpkin either the stamen or the pistil is absent, i.e. only one sexual part is present. Such flowers are said to be *unisexual flowers* (Fig. 11.5). If the pistil alone is present they are called *pistillate* flowers and if the stamen alone is present, they are known as *staminate* flowers.

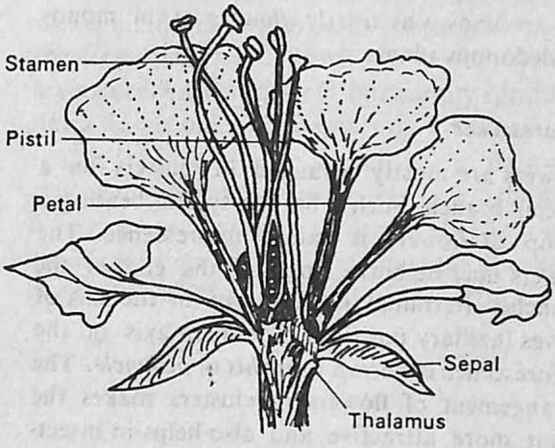
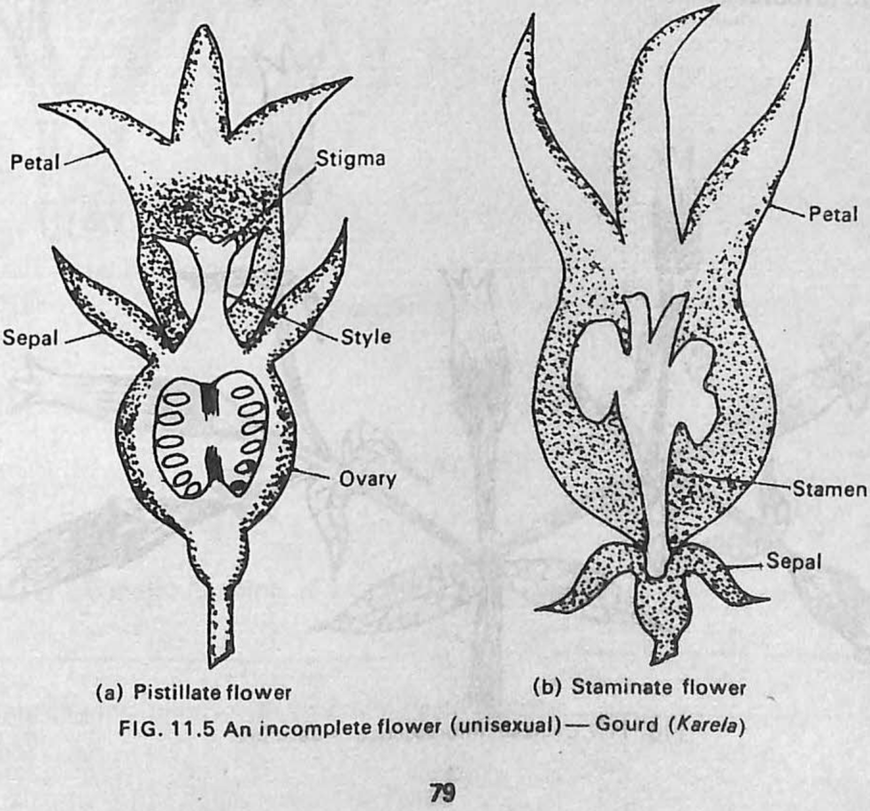


FIG. 11.4 A complete flower (bisexual)—Gulmohar

Most flowers have a stalk or pedicel. Such flowers are known as *pedicellate flowers*. However, some flowers do not have a pedicel. Such flowers are directly attached to the floral axis



(a) Pistillate flower

(b) Staminate flower

FIG. 11.5 An incomplete flower (unisexual)—Gourd (*Karela*)

and are known as *sessile flowers* as in monocotyledonous plants.

Inflorescence

Flowers are mostly arranged in clusters on a special branch. Such a branch system bearing a group of flowers is called inflorescence. The flowers may be borne singly at the end of the branches (terminal position) or in the axis of leaves (axillary position). The main axis of the inflorescence is known as *rachis* or *peduncle*. The arrangement of flowers in clusters makes the plant more attractive and also helps in insect-pollination. There are three principal types of inflorescence—*racemose* (or *indeterminate*) *cymose* (or *determinate*) and *capitulum* (or *head*).

RACEMOSE INFLORESCENCE

In this (Fig. 11.6) the rachis is elongated, bears the oldest flowers at the base and the youngest at the apex. Flowers can be pedicellate or sessile. The rachis bears a vegetative bud at the terminal end, and therefore grows indefinitely as long as conditions are favourable.

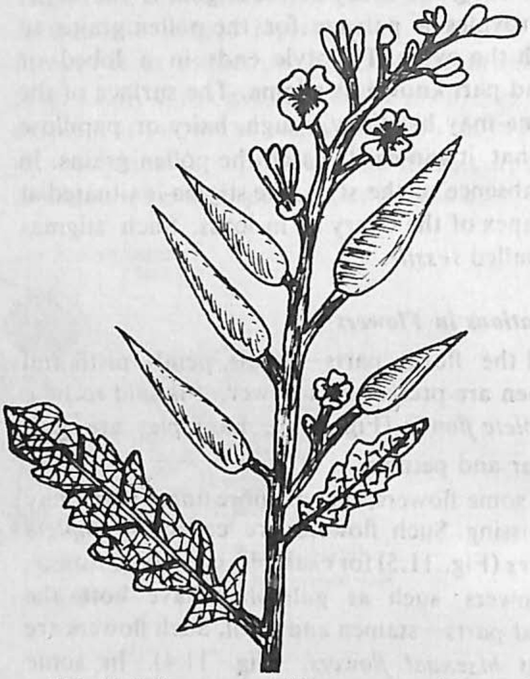


FIG. 11.6 Racemose inflorescence — Mustard

CYMOSE INFLORESCENCE

In this case (Fig.11.7), the linear growth of the

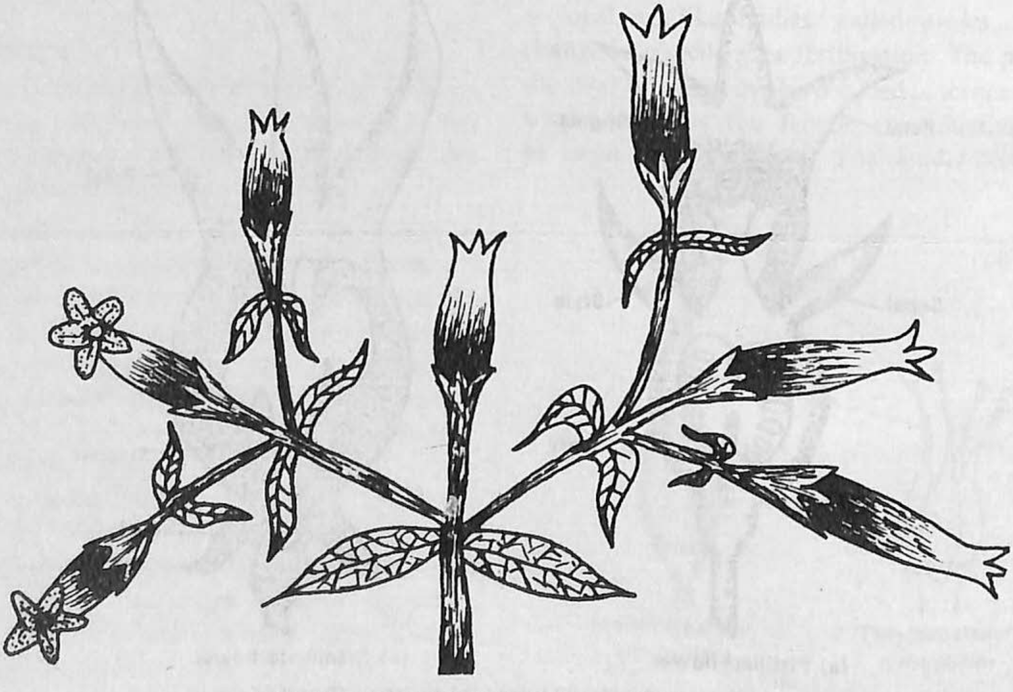


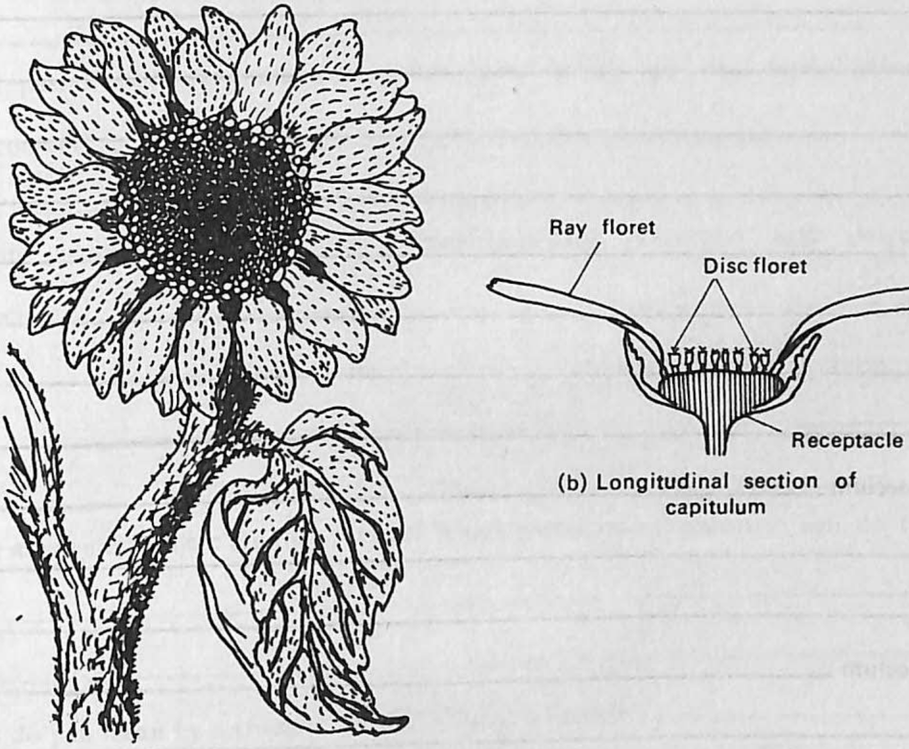
FIG. 11.7 Cymose inflorescence— Jasmine

axis does not occur as the terminal end of the main axis does not bear a vegetative bud. Instead, the main axis and its branches bear flower buds at the apex. The terminal flowers that are at the apex are the oldest and the lateral ones are younger.

CAPITULUM INFLORESCENCE

This type of inflorescence (Fig.11.8) is found in sunflower, marigold, chrysanthemum, etc. The rachis is a flattened, more or less convex disc, in which old florets are towards the periphery and the new ones are towards the centre. What a layman calls a sunflower is, botanically speaking, not a flower but an inflorescence.

The sunflower inflorescence has a flattened convex disc known as *receptacle*, in which small flowers known as *florets* are arranged. The florets are of two types—*ray florets* towards the periphery and *disc florets* towards the centre.



(a) Full inflorescence

(b) Longitudinal section of capitulum

FIG. 11.8 Capitulum inflorescence—sunflower

EXERCISES

1. What is the major function of a flower? ________________

____

2. Name any two plants with bright coloured flowers. ________________

3. Name the reproductive parts of a flower. ______

4. How do sepals and petals help a flower? ______

5. Give the structure and functions of the following.

Thalamus ______

Calyx ______

Corolla ______

Androecium ______

Gynoecium ______

6. What do you understand by the terms, 'polysepalous' and 'gamosepalous'? ______

7. What do you mean by persistent calyx? ______

8. Explain the terms petaloid and sepaloid, giving suitable examples. ______

9. What properties of the corolla help in attracting insects for pollination?

10. Which part of the flower contains the pollen grains? Which important reproductive cell do they contain?

11. Explain giving examples the terms 'monocarpellary gynoecium' and 'polycarpellary gynoecium'.

12. What are ovules? Where are they present? Which important reproductive cell do they contain?

13. What do you mean by a complete flower? Give an example.

14. What do you mean by bisexual and unisexual flowers? Give an example of each.

15. What are 'pistillate' and 'staminate' flowers? Give examples.

16. What is an inflorescence? Name the various types of inflorescences.

17. How is racemose inflorescence different from cymose inflorescence?

18. What is a capitulum inflorescence? Give two examples.

19. How do insects help plants?

20. Draw a labelled diagram showing the parts of a flower.

12

Pollination

A visit to a garden or to the fields is a pleasure for everyone. It is a treat to watch the beautiful flowers, and the bees and the butterflies fluttering about and perching on the flowers every now and then. A close observation will reveal yellow, powdery, dust-like particles clinging to the legs of these insects. This yellow powder is the *pollen*. While the insects are busy visiting the flowers in search of their food, they unknowingly help the plants in one of the very important processes called *pollination*, which is essential for fertilisation to take place.

The ovules or female cells inside the carpels ultimately develop into seeds. However, this can happen only when they are fused with the male cells contained in the pollen tube of the pollen grains. When the pollen is ripe the pollen sacs of the anther burst and the pollen is exposed. It is now necessary, for fertilisation to take place, that the pollen grains reach the stigma of the carpel. The process by which the pollen is transferred is called pollination. Pollination is of two types—*self* and *cross* pollination (Fig. 12.1).

SELF POLLINATION

Self pollination occurs when the pollen grains from the anther of a flower are transferred to the stigma of the same flower or between different flowers of the same plant. It mostly takes place in bisexual flowers such as pea.

CROSS POLLINATION

When the pollen is transferred from the flowers of one plant to the flowers of another plant, of the same species, the process is called cross pollination. It can occur in either unisexual or bisexual flowers. In nature, flowers are usually cross-pollinated.

Advantages of Cross Pollination

The progeny developed from this process is more healthy and strong. Improved varieties can be produced. The fruits and seeds can be of better quality. Much scientific research nowadays is concentrated on development of new varieties of seeds, fruits and vegetables by artificial cross pollination, which are more disease resistant and give better yield.

Self pollination does not need any external agency, whereas cross pollination requires the help of an external agent. The natural agents are air, water, insects and birds. Based on the agents,

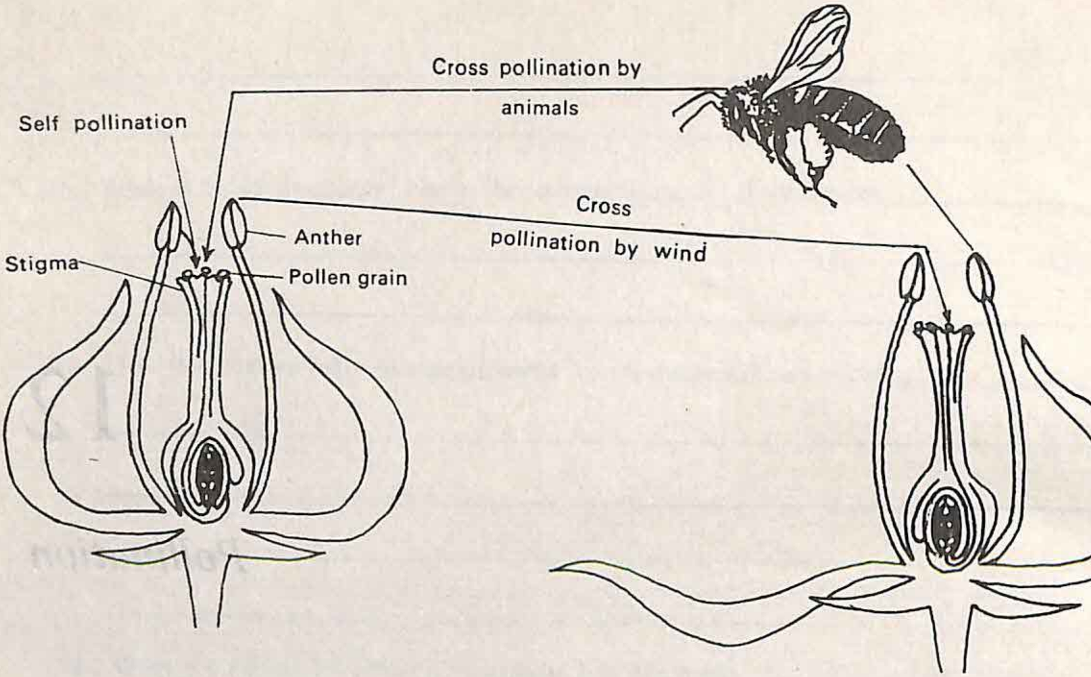


FIG. 12.1 Types of pollination

cross pollinated flowers are categorised as *entomophilous* flowers, *anemophilous* flowers, *hydrophilous* flowers and *zoophilous* flowers.

ENTOMOPHILOUS FLOWERS (entomon = insect)

These flowers are generally pollinated by butterflies, honey bees and other insects. The flowers are brightly coloured to attract the insects. It is observed that different insects are attracted by different colours, for example wasps are attracted by deep brown colour, and butterflies by red or scarlet colour. When the individual flowers are not attractive, an inflorescence can attract the insects by their collective appearance as in sunflower.

Some insects are attracted by odour; flowers such as jasmine or cestrum (night queen) have strong odour and attract moths at night. Such flowers are usually white.

Besides having attractive colour and odour, entomophilous flowers produce nectar in the nectar gland in special structures called *spurs*. They are usually located at the base of the petals. The long tongue of the insect reaches the base to draw the nectar. While doing so, it brushes against the anthers and picks up pollen grains on its hairy body. It then flies to another flower, and while it is drawing the nectar it brushes against the stigma and leaves some of the pollen grains on it. It thus helps in pollination (Fig. 12.2).

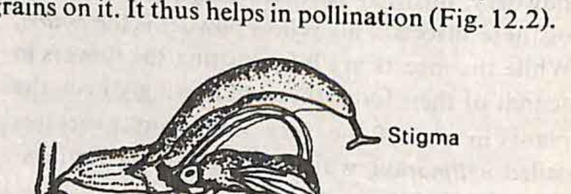

Stigma
Anther deposits pollen grains into insect's back
Pollen grains transferred to stigma of another flower

FIG. 12.2 Pollination in Salvia

ANIMOPHILOUS FLOWERS (anemos = wind)

In most flowers belonging to monocotyledonous plants, the wind helps in pollination (Fig. 12.3). The flowers are unisexual and are usually small,

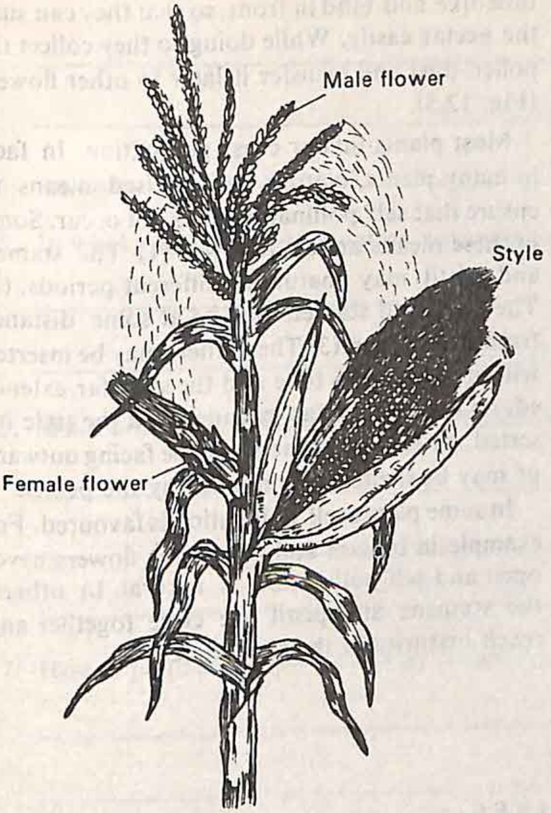


FIG. 12.3 Cross pollination by wind

unattractive and white in colour. The female flowers are situated on the lower parts of the plant and the male flowers grow on the upper parts. The filaments of the stamen are usually long and are attached to the anther lobes in the middle. Such anthers are called *versatile* anthers. Their structure makes it easier for them to sway in the air and disperse the pollen grains, which are produced in large amounts and are dry and light. The stigmas are branched and hairy to trap the pollen grains travelling in the air. In wheat and paddy flowers the stigmas are feathery.

Hydrophilous Flowers (hydro = water)

These flowers are pollinated by water. Like anemophilous flowers, water pollinated flowers are also small and unattractive, except in lotus. They also lack fragrance and nectar. All aquatic flowers however, are not pollinated by water. For example the lotus flower is pollinated by insects. The flowers of such aquatic plants are lifted to the surface of water, so that they can be pollinated by wind or insects.

Water pollinated flowers are mostly unisexual. The male and female flowers are borne by separate plants as in vallisnaria (Fig. 12.4). Both of them grow under the surface of water. The male flower after maturity detaches itself from the inflorescence and floats on the surface of water (Fig. 12.4). The female flower uncoils its long pedicel at maturity and raises itself up to the water surface. The female flower is slightly waxy, and forms a depression in the film of water. The male flowers collect in the depression while the petals of the female flower move apart to expose the hairy stigma. After pollination the flower stalk recoils, carrying the fertilised ovum down to the bottom of the water for further development of the fruit. A truly fascinating phenomenon!

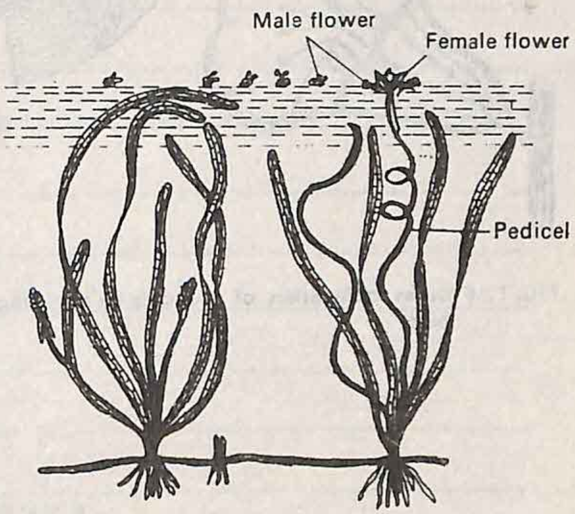


FIG. 12.4 Cross pollination by water in vallisnaria

Zoophilous Flowers (zoon = animal)

A few small-sized birds (Fig.12.5), snails, bats, etc. help in pollination of the zoophilous flowers. Among the birds, the humming birds and honey thrushes are the common pollinating agents. They spot out the flowers, their favourite being red or orange coloured flowers (bignonia, pomegranate, etc.) from a distance. Their tongues are

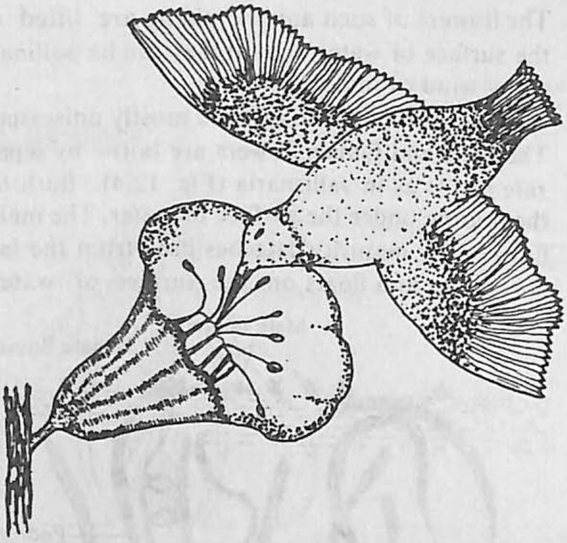


FIG. 12.5 Cross pollination of bignonia by humming bird.

tube-like and bifid in front, so that they can suck the nectar easily. While doing so they collect the pollen dust and transfer it later to other flowers (Fig. 12.5).

Most plants favour cross pollination. In fact, in many plants, Nature has devised means to ensure that self pollination does not occur. Some of these means are as follows. (1) The stamen and pistil may mature at different periods. (2) The pistil and stamen may be at some distance from each other. (3) The anthers may be inserted within the corolla tube and the style far extended, or the anthers far extended and the style inserted, or else the anthers may be facing outward or may be sheltered or hooded by the petals.

In some plants self pollination is favoured. For example in balsam and pansy, the flowers never open and self pollination is natural. In others, the stamens and pistil are close together and reach maturity at the same time.

EXERCISES

1. Why do butterflies and other insects visit the gardens?
2. How do the visits of butterflies and insects help the plants?
3. What is pollination? Name the various types of pollination.
4. How is self-pollination different from cross-pollination?

5. In what way is cross-pollination advantageous?

6. What are insect-pollinated flowers called? What are their characteristics?

7. How is pollination carried out by insects?

8. Where is nectar found in a flower?

9. What are anemophilous flowers?

10. Why are anemophilous flowers usually unattractive?

11. How is pollination carried out in anemophilous flowers?

12. Why are pollen grains in a wind pollinated flower produced in large amounts?

13. What are hydrophilous flowers? What are their characteristics?

14. Do all the flowers of aquatic plants pollinate by water? Give an example where a flower of an aquatic plant is pollinated by insects.

15. Explain the process of pollination in vallisnaria.

16. Which animals help pollination in zoophilous flowers?

17. How is self-pollination prevented in nature?

13

Fertilisation

Fertilisation is the process by which the fusion of the two reproductive cells or gametes – male and female – takes place. It was first discovered in flowering plants by Strasburger in 1884. After pollination, that is after the pollen grains reach the stigma, each pollen grain starts developing a tube called the *pollen tube* (Fig. 13.1). The tube as it grows penetrates the stigma and pushes itself through the style and along the side of the ovary wall. The pollen grain carries in it two male gametes. The tube enters the embryo sac through an opening known as the *micropyle*.

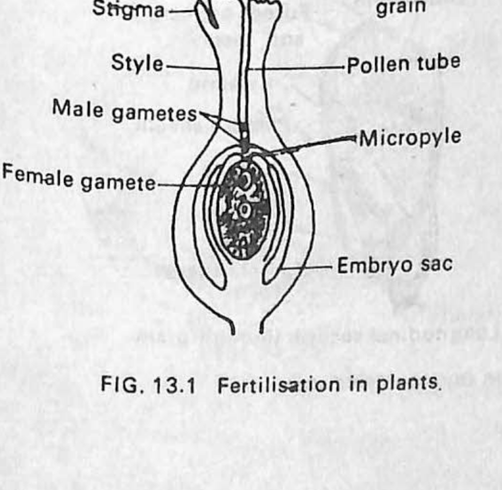


FIG. 13.1 Fertilisation in plants.

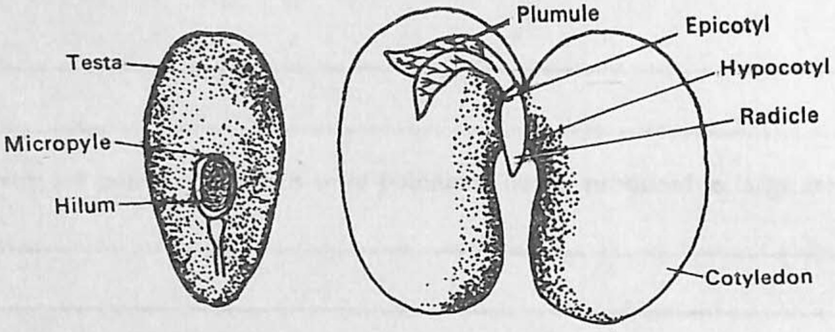
The tip of the pollen tube then bursts and one of the male gametes fuses with the female nucleus to form a *zygote*. This process is known as *fertilisation*. The other male nucleus may fuse with one of the other nuclei of the embryo sac, called the secondary nucleus to form the *primary endosperm*.

After fertilisation the zygote divides and subdivides to form the *embryo* or the young plant. The ovule forms the seed and the ovary the fruit. The primary endosperm also undergoes division and subdivision to form the reserve food of the seed.

After fertilisation, the sepals, petals, stamens, style and stigma usually wither and fall off. The ovary wall forms the fruit wall which can be hard and dry, or soft and fleshy.

The Seed

A seed (Fig. 13.2) is a fertilised ovule. It consists of an outer protective layer called *testa* which has a tiny aperture called the *micropyle* which allows water to go in. The testa encloses the *embryo* which contains a *radicle* and a *plumule*. Food is stored in one or two *cotyledons*



(a) Whole seed (b) Embryo with cotyledon split open

FIG. 13.2 Structure of a bean seed (dicotyledon)

and the *endosperm.* On one side of the seed is a scar called the *hilum*, which marks the point where the seed has broken away from the stalk. The region between the radicle and plumule below the point of attachment of the embryo to the cotyledon is known as the *hypocotyl.* The region above this point is the *epicotyl.*

The testa protects the seeds from fungi and bacteria. It is split open before germination starts.

The radicle is on the lower side of the hypocotyl. It grows into the root.

The plumule is the future shoot. It is made up of two embryonic leaves, which become the first true leaves of the seedling, and a terminal bud. Further growth of the stem takes place by the meristematic cells at the terminal bud.

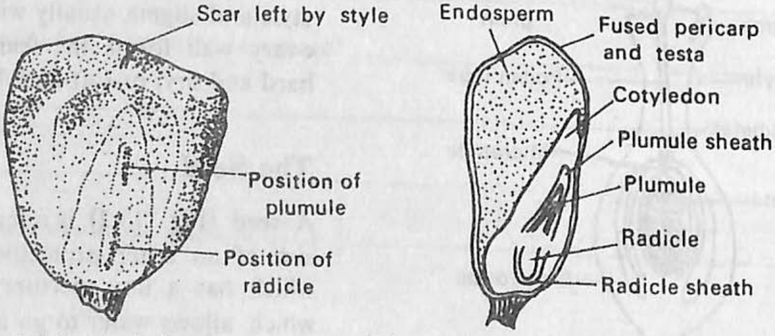
In seeds such as bean and castor, there are two cotyledons. Such seeds are known as *dicotyledonous* seeds (e.g. bean, Fig. 13.2). Seeds such as maize have only one cotyledon; such seeds are called *monocotyledonous* seeds (Fig. 13.3). Cotyledons of a seed store food to nourish the growing embryo. The food is derived from the endosperm. In many angiosperms (e.g. beans) the endosperm is absent and the food reserves are transferred to the cotyledons by the time the seed matures. Such seeds are known as *non-endospermic* seeds. In other plants such as maize the endosperm persists in the mature seed. Such seeds are known as *endospermic* seeds.

The seed is thus a dormant embryo with stored food and protective coats. Its dual functions are to disperse the species, and to preserve the species over periods of unfavourable climatic conditions. When conditions become favourable for growth of the plant, germination of seeds occurs and a new generation of plants develops.

Structure of Seeds

THE BEAN SEED

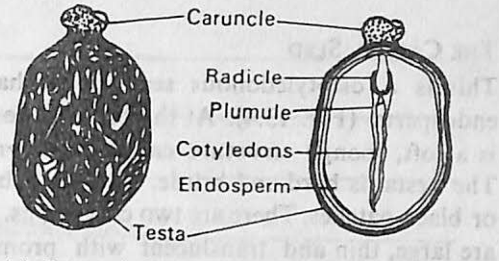
This is a dicotyledonous seed having no endo-



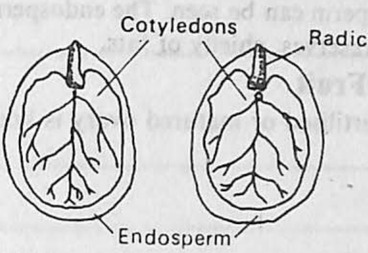
(a) External view (b) Longitudinal section through grain

FIG. 13.3 Structure of a maize grain (monocotyledon)

sperm. On the concave side of the seed a small scar can be seen at the place where it was attached to the fruit (Fig. 13.2). Near the scar is the small opening called *micropyle*, through which the pollen tube enters the ovule. The seed coat protects the seed. Its colour may be white, red or yellow. The seed coat can easily be taken out after soaking the seeds overnight. On opening the seed, one finds two kidney-shaped cotyledons. In between the two cotyledons, sticking to the inner side at the upper end, is a curved structure, consisting of the radicle and plumule. Hypocotyl is the region between these two organs. The radicle grows into the root, the plumule to the shoot. The cotyledons are large and fleshy, and possess food reserve of starch and proteins.



(a) External view (b) Longitudinal section

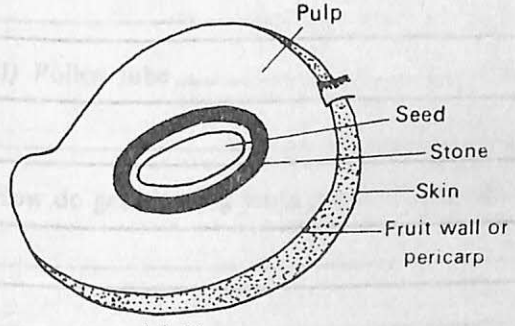


(c) Halves with seed coats removed

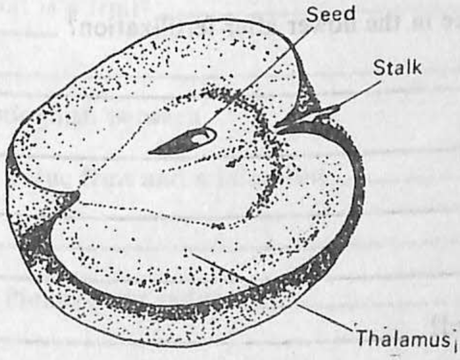
FIG. 13.4 Structure of castor seed (dicotyledon)

THE MAIZE SEED

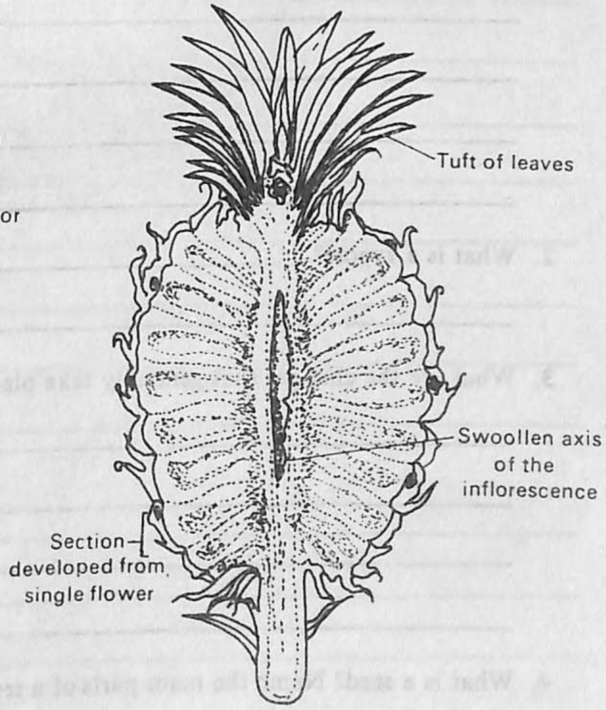
This is an endospermic, monocotyledonous seed (Fig. 13.3), like wheat and paddy. It is really a fruit with the ovary wall *(pericarp)* fused with the testa. The bulk of the grain is constituted by the endosperm, and the embryo lies on one side of it. The outermost layer of the endosperm consists of protein grains.



(a) Mango



(b) Apple



(c) Pineapple

FIG. 13.5

THE CASTOR SEED

This is a dicotyledonous seed which has an endosperm (Fig. 13.4). At the base of the seed, is a soft, spongy structure called the *caruncle.* The testa is hard and brittle, with dark brown or black patches. There are two cotyledons. They are large, thin and translucent with prominent veins. On removing the *testa*, a white mass of endosperm can be seen. The endosperm contains food reserves, chiefly of fats.

The Fruit

The fertilised or matured ovary is known as the fruit. The ovary wall becomes the fruit wall or *pericarp* enclosing the seeds. A fruit developed from the ovary is said to be a *true fruit*, e.g. tomato or mango (Fig. 13.5a). Sometimes other floral parts such as the thalamus, participate in the formation of fruit. Such a fruit is called a *false fruit*, e.g. apple (Fig. 13.5b). When the fruits are formed from the whole inflorescence, as in pineapple or jackfruit, it is called a *composite fruit* (Fig. 13.5c).

EXERCISES

1. What is fertilization? Who discovered fertilization in plants and when?
2. What is a zygote?
3. What are the changes that generally take place in the flower after fertilization?
4. What is a seed? Name the main parts of a seed?

5. What is the dual function of a seed? ______________________________

____

____

6. Distinguish between monocolyledonous and dicotyledonous seeds. ______________________________

____

____

7. What are the functions of the following?

(a) Testa ______________________________

____

(b) Endosperm ______________________________

____

(c) Micropyle ______________________________

____

(d) Pollen tube ______________________________

____

8. How do germinating seeds get their nourishment? ______________________________

____

____

9. What is a fruit? ______________________________

____

10. Distinguish between

(a) a true fruit and a false fruit ______________________________

____

(b) Plumule and radicle ______________________________

____

(c) Endospermic and non-endospermic seed ______________________________

14

Dispersal of Seeds and Fruits

Seeds have to be separated from fruits for them to germinate into new plants. Plants produce a number of seeds. If all the seeds fall and germinate under the parent plant, they will have to compete with each other and the parent plant for the basic needs such as space, air, light, water, minerals, etc. Many of them may die due to overcrowding. To reduce this overcrowding, seeds have to be carried away from the parent plant. Nature has developed several devices by means of which seeds can be distributed far and wide. The distribution of seeds away from the parent plant is called *dispersal* of seeds.

Fruits such as pea and bean, open (dehisce) along the pores or one or more regular lines on maturity. Such fruits are known as *dehiscent* fruits (Fig. 14.1). In these fruits only the seeds are dispersed. Fruits such as brinjal and tomato do not dehisce. Such fruits are called *indehiscent* fruits (Fig. 4.2). Seeds of such fruits have to be brought

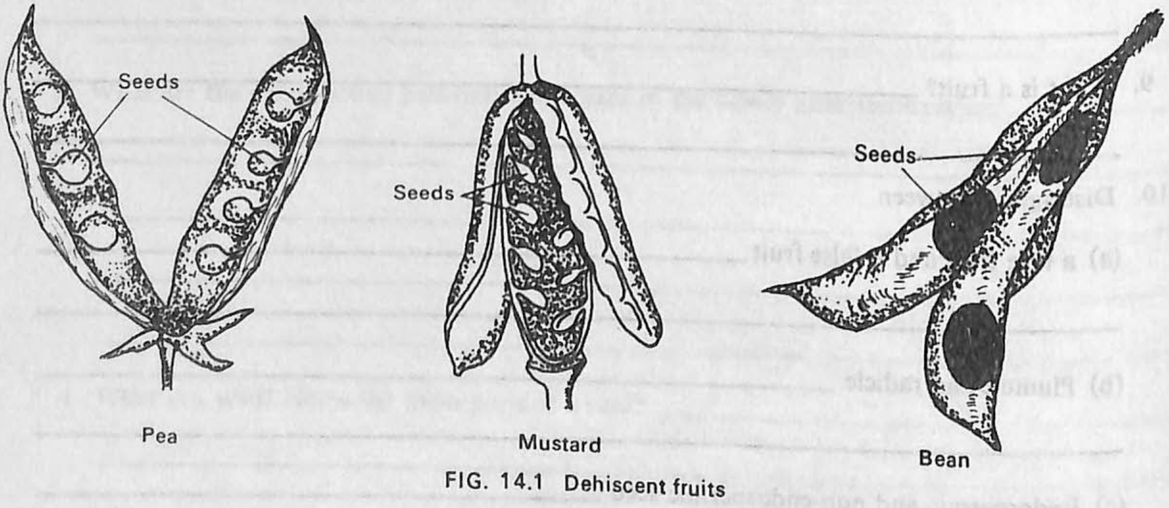


FIG. 14.1 Dehiscent fruits

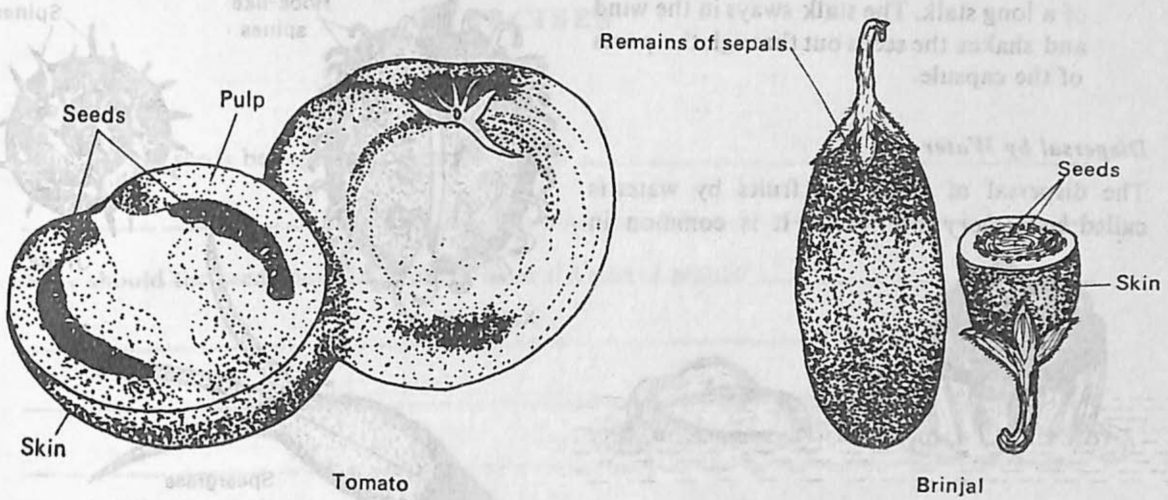


FIG. 14.2 Indehiscent fruits

out of the fruits for dispersal. In indehiscent fruits the fruits themselves, with the seeds inside them, are dispersed.

Agents for Dispersal of Seeds

The seeds that are released from the fruits are dispersed by various natural agents such as wind, water, birds and other animals, including man. In some plants, fruits mechanically burst open to throw out the seeds, as in balsam.

Dispersal by Wind

The dispersal of seeds or fruits by wind is called *anemochory* (Fig. 14.3). Such seeds are either very small and light or have hair or wing-like structures because of which they are easily carried away by air. The ways in which seeds are dispersed by air are as follows.

(a) The seeds may be so small and light that they can easily be carried by the wind, e.g. orchid, balsam.

(b) Some seeds and fruits are *winged*, and are carried by the wind, e.g. seeds of maple.

(c) In plants such as dandelion, the calyx is modified into a parachute-like tuft of hair known as *pappus*. It opens out like an umbrella and helps the fruit to fly.

(d) In plants such as cotton, the seed is surrounded by a mass of fine threads so that they are easily blown about by the wind.

(e) Seeds of poppy are dispersed by the wind, helped by the *censer mechanism*. The seeds are present in a capsule (fruit) at the end

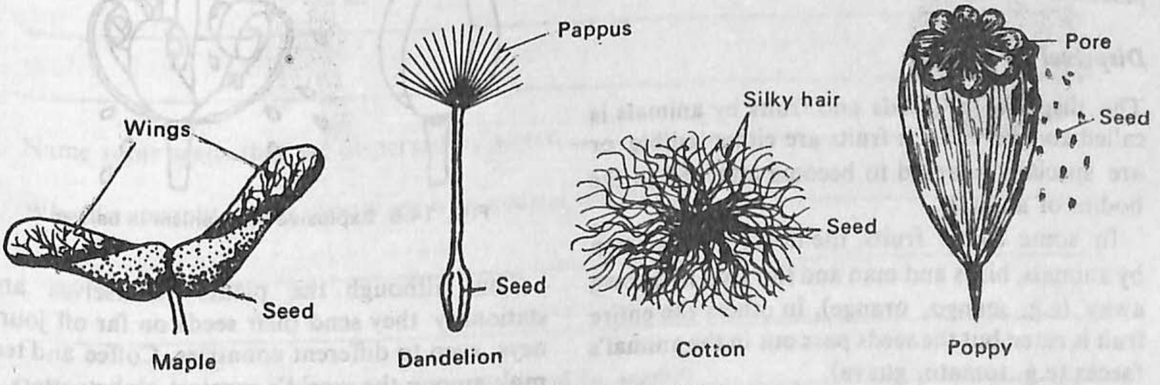
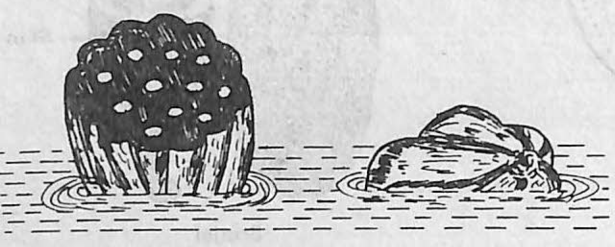


FIG. 14.3 Dispersal by wind

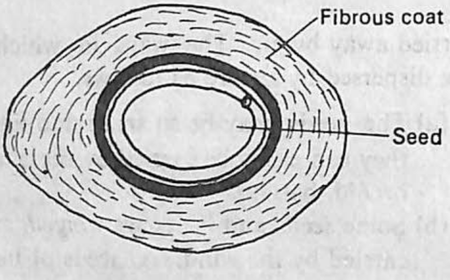
of a long stalk. The stalk sways in the wind and shakes the seeds out through the pores of the capsule.

Dispersal by Water

The dispersal of seeds and fruits by water is called *hydrochory* (Fig. 14.4). It is common in aquatic and water-side plants. Examples are coconut, lotus and screwpine. They usually have floating devices in the form of fibrous outer coats. The fibrous fruit of coconut is capable of floating hundreds of miles in seas without being damaged by the saline water. Hence the coconut forms a characteristic vegetation of coastal places.



(a) Lotus and coconut floating in water



(b) Longitudinal section of coconut fruit

FIG. 14.4 Dispersal by water

Dispersal by Animals

The dispersal of seeds and fruits by animals is called *zoochory*. Such fruits are either edible or are specially adapted to become attached to the bodies of animals.

In some edible fruits, the fleshy part is eaten by animals, birds and man and the seed is thrown away (e.g. mango, orange). In others the entire fruit is eaten but the seeds pass out in the animal's faeces (e.g. tomato, guava).

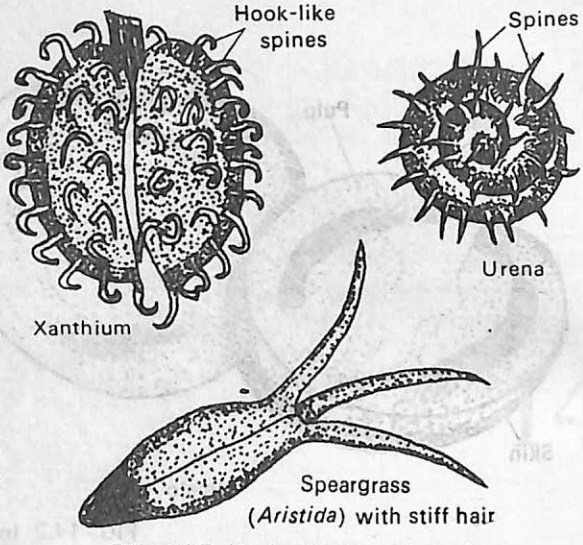


FIG. 14.5 Hooked fruits and seeds

Some fruits are provided with hooks, barbs, spines, sticky hairs, etc. on their coats (Fig. 14.5) by which they become entangled to the fur and skin of animals and clothes of men and thus reach long distances. Examples are xanthium and spear grass.

Explosive Mechanism

Some fruits dry up on maturity. This creates a strain on its walls causing it to burst and throw out the seeds. This method of dispersal of seeds is commonly observed in beans, balsam etc. (Fig. 14.6).

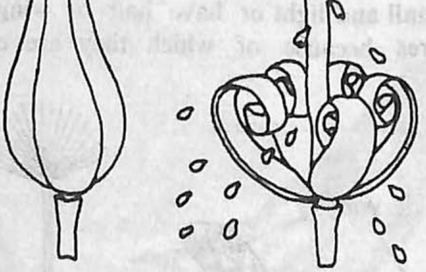


FIG. 14.6 Explosive mechanism in balsam

Thus although the plants themselves are stationary they send their seeds on far off journeys, even to different countries. Coffee and tea rank among the world's greatest globetrotters.

EXERCISES

1. Why should seeds be separated from the fruits?

2. Why should the seeds be carried away from the parent plants?

3. What is dispersal of seeds?

4. What do you mean by dehiscent and indehiscent fruits? Give examples.

5. Which natural agents help in the dispersal of seeds?

6. List the characteristics of seeds that help in their dispersal by wind? Give examples.

7. Name some seeds that are dispersed by water.

8. Why do coconut palms mostly grow in coastal places?

9. How are the coconut seeds suited for dispersal by water?

10. How are the seeds of edible fruits dispersed?

11. The fruit of xanthium is provided with hooks. Why?

12. What is the role played by man in dispersal of seeds?

13. Briefly explain how the explosive mechanism helps in dispersal of seeds.

14. Do all fruits contain seeds?

15. Very often we find plants germinating from cow-dung cakes. Explain how this is possible.

15

Germination of Seeds

Seed Dormancy and Germination

When conditions necessary for germination are provided, some seeds will germinate soon after maturation. Some, such as cereal seeds, may not germinate immediately. Such seeds which do not germinate immediately after maturation are said to be *dormant*. After the dormancy period is over and suitable conditions (water, oxygen and suitable temperature) are provided, the seeds begin to germinate. The seeds get swollen up once they absorb water and the embryo in the seed gets activated. The development of radicle and plumule takes place. The process by which the embryo gets activated and begins to grow into a new plant is called *germination*. Germination can be *hypogeal*, when the cotyledons remain underground as in castor; or *epigeal*, when the cotyledons are carried above the soil as in bean.

Germination of Maize Seed

The germination of maize seed (Fig. 15.1) is hypogeal. The grain absorbs water and the part of the cotyledon which forms a protective covering round the radicle elongates and pierces the grain. Then the radicle pushes its way out by tearing the covering. The torn edges of the cover-

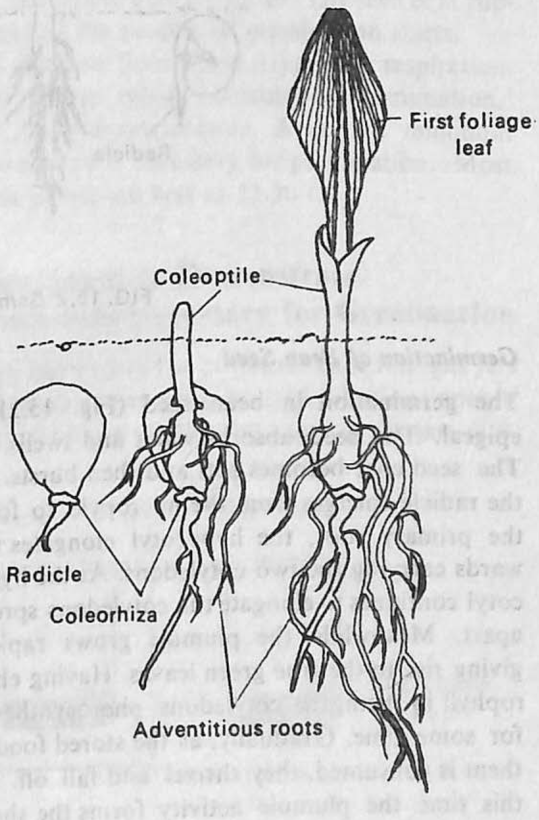


FIG. 15.1 Germination of maize seed

ing form a collar round the radicle known as *coleorhiza*. Thus the primary root is formed. A few days later the part of the cotyledon surrounding the plumule, known as the *coleoptile* also elongates and pierces the grain in the opposite direction. The plumule breaks through and the first foliage leaves open out. The first leaves of the plumule are protected by the coleoptile. From the base of the plumule adventitious roots grow. The cotyledon remains below the soil, absorbing food from the endosperm and transferring it to the growing root and shoot. Thus a young maize plant emerges and grows into an adult one.

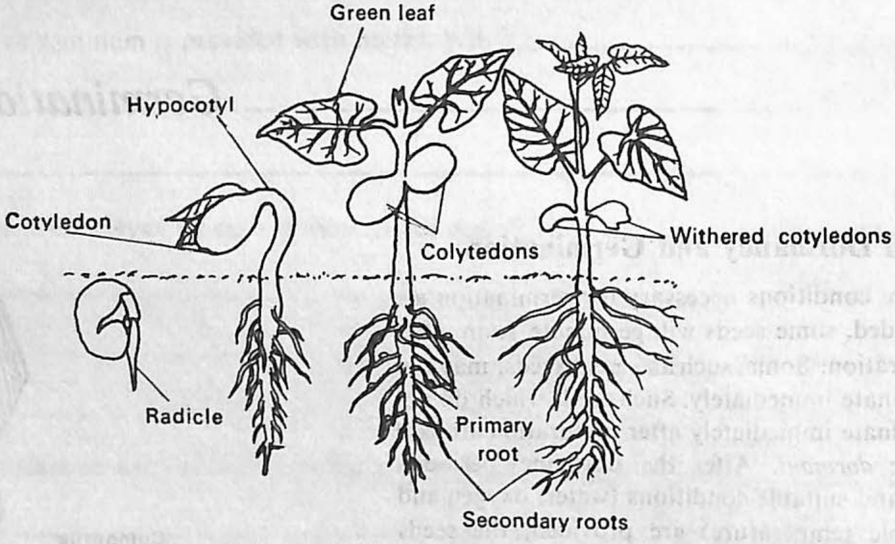


FIG. 15.2 Germination of bean seed

Germination of Bean Seed

The germination in bean seed (Fig. 15.2) is epigeal. The seed absorbs water and swells up. The seed coat becomes soft and then bursts. As the radicle emerges from the micropyle to form the primary root, the hypocotyl elongates upwards carrying the two cotyledons. As the hypocotyl continues to elongate the cotyledons spread apart. Meanwhile the plumule grows rapidly giving rise to the true green leaves. Having chlorophyll in them, the cotyledons photosynthesise for some time. Gradually, as the stored food in them is consumed, they shrivel and fall off. By this time the plumule activity forms the shoot system and the radicle forms the root system.

Germination of Gram and Pea Seeds

These seeds germinate hypogeally (Fig. 15.3). When conditions are favourable, the seed absorbs large quantities of water and swells up. The seed coat gets ruptured, allowing the radicle to come out as it elongates. It then bends down and forms the primary root. Simultaneously the epicotyl elongates and forms a small loop for some time. The plumule, at the tip, stretches itself by freeing from the two cotyledons on either side. Due to the elongation of the epicotyl, the cotyledons remain at the ground level or even covered with soil. The cotyledons ultimately shrivel and fall off when their food supply is finished.

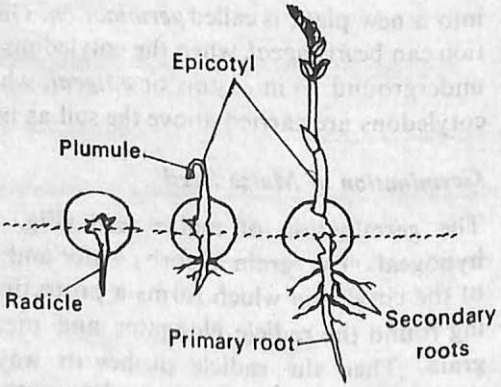


FIG. 15.3 Germination of pea seed

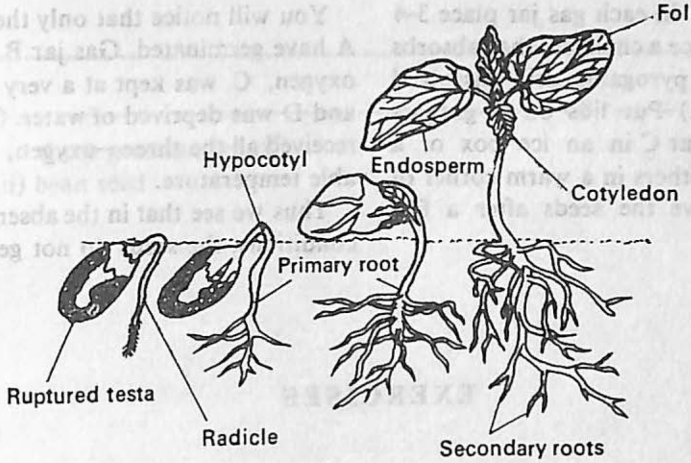


FIG. 15.4 Germination of castor seed

Germination of Castor Seed

Germination of castor seed is epigeal (Fig. 15.4). When conditions are favourable, the seed absorbs considerable amount of water. The shell-like seed coat ruptures at the radicular end. The radicle elongates, pierces the endosperm and comes out of the ruptured testa. The radicle bends and enters the soil to form the primary root. Meanwhile the hypocotyl elongates forming an arch and then straightens up. As it straightens, the cotyledons enveloped by the endosperm and testa rise into the air. When the food stored in the endosperm is almost exhausted, the cotyledons and the enclosed plumule leave the endosperm and come out. After the hypocotyl is completely straightened, the two cotyledons move outwards, become green and form cotyledon leaves. The plumule begins to grow into the shoot from which foliage leaves develop.

Conditions Necessary for Germination of Seeds

1. *Water:* Dry seeds cannot germinate. If a seed is placed in water it absorbs water through the micropyle and swells up. The seed coat ruptures and the process of germination starts.

2. *Oxygen:* Seeds need oxygen for respiration. This releases energy necessary for germination.

3. *Suitable temperature:* A certain minimum temperature is necessary for germination. Most seeds germinate best at 25-30°C.

Experiment to Demonstrate Conditions Necessary for Germination

Soak bean seeds for 24 hours. Take four gas jars and place cotton wool or thick blotting paper in them. Moisten the blotting paper in gas jars A,B

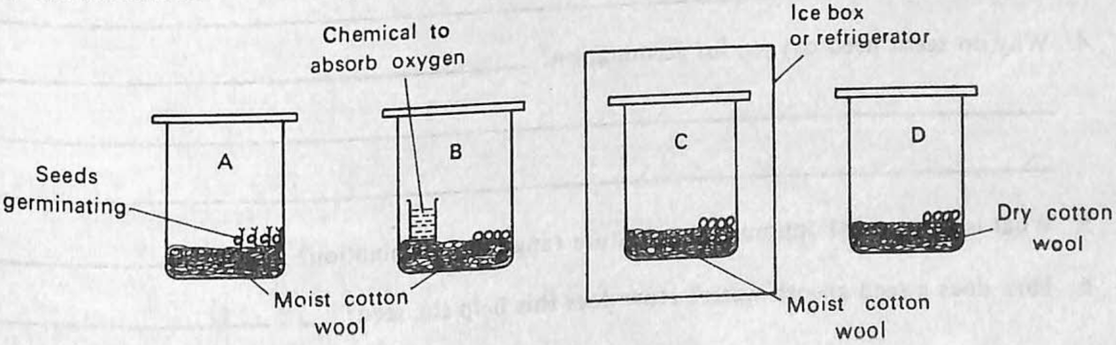


FIG. 15.5 Conditions necessary for germination

and C, but not in D. In each gas jar place 3-4 seeds. In gas jar B place a chemical that absorbs oxygen. (You can use pyrogallic acid dissolved in sodium hydroxide.) Put lids on all gas jars (Fig. 15.5). Place the jar C in an ice box or a refrigerator and the others in a warm corner of the laboratory. Observe the seeds after a few days.

You will notice that only the seeds in gas jar A have germinated. Gas jar B was deprived of oxygen, C was kept at a very low temperature and D was deprived of water. Only the gas jar A received all the three—oxygen, water and a suitable temperature.

Thus we see that in the absence of any of these conditions, the seeds do not germinate.

EXERCISES

1. What is germination? What are the conditions necessary for germination? ____________

2. What are dormant seeds? ____________

3. Explain hypogeal and epigeal germination. Give one example of each. ____________

4. Why do seeds need oxygen for germination? ____________

5. What is the normal optimum temperature range for germination? ____________

6. How does a seed absorb water? How does this help the seed? ____________

7. Draw diagrams to show germination of
(i) maize seed (ii) bean seed

16

The Earthworm and Its Economic Importance

Habitat and Habits

Earthworms belong to the phylum Annelida. They live in moist soil in fields, gardens or near water. They prefer soils rich in humus (dead organic matter) and avoid acidic, sandy and dry earth. They are free living animals, i.e. they seek their own food.

Earthworms are *nocturnal* animals, i.e. they are active at night. They remain inactive during the day burrowing in the soil, and come out and crawl about in the night in search of food. During rainy days, when their burrows are flooded with water, they come out and can be seen crawling on the soil.

The earthworm burrows its way through the soil partly by force and partly by eating the soil as it moves along. It obtains its nourishment from the decayed plant and animal remains present in the soil. The soil that is passed out of the body forms little heaps knows as *casts* at the entrance to the burrows.

External Features

The body of the earthworm is cylindrical, with both ends tapering. This is an adaptive feature of the earthworm for its burrowing mode of life.

The earthworm has deep brown skin, darker on the dorsal surface than on the ventral surface. The rich brown colour is due to a pigment called *porphyrin* present in the skin. This pigment is derived from the chlorophyll of decayed matter such as dead leaves. It is understood that this pigmentation provides protection to the animal from the bad effects of light to which it is susceptible. The surface of the earthworm is moist as it is covered by a secretion from tiny glands. This protects the skin from bacteria and fungi and also acts as a lubricant during its movement through the soil.

The entire surface of the body is marked by circular grooves or *annuli*, dividing the body into 100-120 segments or *metameres*. Internally the body cavity is also divided into similar number of units corresponding to the external ones. This type of segmentation is called *metameric segmentation*.

The first segment is called *peristomium* and surrounds the mouth. There is a prominent circular band called *clitellum* surrounding five or

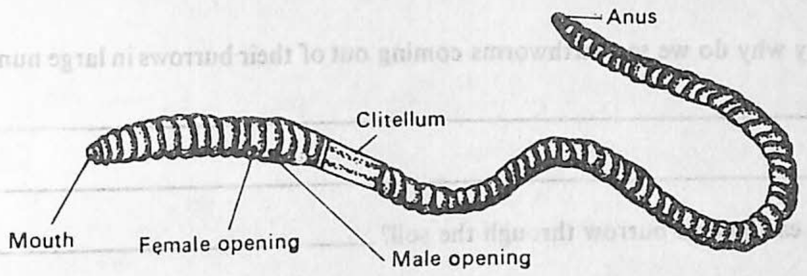


FIG. 16.1 The earthworm

six segments about quarter of the way along the body from the front in mature animals. This secretes the cocoon in which the earthworm lays its eggs.

The earthworm is a *hermaphrodite* (bisexual) animal having both male and female reproductive organs in the same body. The opening of the male reproductive organ can be seen on the lower side of the fifteenth segment. The dorsal surface of the earthworm bears very minute pores called *dorsal pores* which are scattered all over the body surface. The last segment bears the anal aperture and hence is called the *anal segment*.

The earthworm has small bristles called *setae* which project from the body wall in two double rows on each side. It uses its setae to get purchase on the ground and then alternately lengthens and shortens its body to move forward.

If an earthworm is cut into two, each half usually grows into a full earthworm, thus resulting in two worms.

Economic Importance

The earthworm is a great friend of the farmer and the gardener. By its burrowing activities it makes the soil porous. The pores are very good for ventilating the soil and areating the roots, and also enabling them to spread. The roots of plants can grow more easily into deeper soil because of the loosened soil. Earthworms bring up new rich soil from below the surface, in the form of worm castings. These castings include nitrogenous waste matter and help in making the soil fertile. Earthworms reduce both acidity and alkalinity of the soil and thus create optimum conditions for plant growth.

Earthworms are used in various medicines to cure human diseases such as jaundice, piles and rheumatism.

Earthworms are used in baiting fish, and also as feed for many other animals.

Earthworms are used in laboratories for dissection work.

EXERCISES

1. Where are earthworms generally found? ______________________

____

2. What are nocturnal animals? Name any two. ______________________

____

____

Table 17.1

Vitamin	*Present in*	*Essential for*	*Deficiency disease*
Vitamin A	Milk, butter, cheese, carrots, tomatoes, cod-liver oil.	Eyes, lungs	Night-blindness
Vitamin B complex (mixture of several vitamins)	Milk, eggs, cheese, meat, liver, husk of cereals and pulses.	Nerves, digestion, growth	beri-beri (nervousness, loss of appetite, paralysis)
Vitamin C (ascorbic acid)	Citrus fruits (orange, lemon, lime) green vegetables, tomatoes.	Muscles and teeth	Scurvy (bleeding of gums and swelling of joints)
Vitamin D	Milk, yellow of egg, liver oils.	Bones	Rickets (decaying teeth, weak distorted bones)
Vitamin K	Green vegetables.	Blood clotting	

is essential for the manufacture of haemoglobin in blood. Iodine is necessary for proper functioning of *thyroid glands* in the neck. Calcium and phosphorus are found in milk, cheese, egg yolk, meat, citrus fruits, green vegetables, potatoes, etc. Iron is found in green vegetables, peas and beans and whole-grain cereals. Iodine is present in fish and iodised salt.

Vitamins are required in small quantities and are essential for proper working of body organs. Lack of any vitamin causes deficiency diseases. Table 17.1 gives the necessary information about important vitamins.

Water: Besides the above nutrients, water should also form a major part of our diet. Water forms about two-thirds of our body weight. It is necessary for transport of materials within the body. It helps to carry food materials to the cell and waste material away from the cell. It is also required to regulate our body temperature. Most food items contain water.

A balanced diet consists of the correct amounts of various nutrients and is essential for proper and healthy working of our bodies.

Nutrition

Nutrition in animals involves four main processes.

(i) *Ingestion* or the taking in of solid food.

(ii) *Digestion* or the simplification and dissolving of the solid food.

(iii) *Absorption* of the dissolved food into the body fluids.

(iv) *Egestion* or discharge of the insoluble parts of the food from the body as faeces.

What is Digestion?

Solid food cannot be directly absorbed by the cells for carrying out metabolic processes. This is because of the following reasons.

(i) Majority of constituents of food are insoluble in water and therefore cannot enter the cell membrane.

(ii) Carbohydrates, proteins and fats are complex substances and must first be broken down into simpler ones.

Digestion is the process responsible for breaking up the complex food molecules to simpler molecules, soluble in water, which can then be absorbed by the cells.

Kinds of Digestion

The process of digestion depends upon the type of animal and the food it takes.

Intracellular digestion occurs within the cell. It is found generally in lower animals such as protozoans (amoeba, paramoecium), sponges, etc.

Extracellular digestion takes place outside the cells in the *digestive tube* or *alimentary canal* of the animal. It is a characteristic of higher animals such as man.

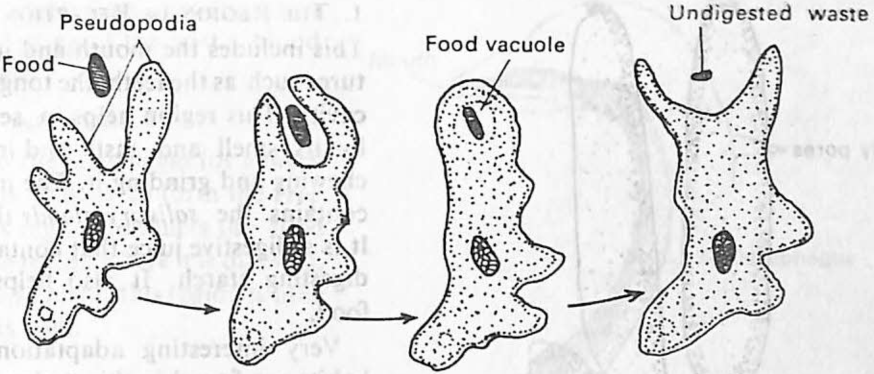


FIG. 17.1 Amoeba catching its prey

Animals such as hydra undergo both types of digestions.

Some internal body parasites (endoparasites) such as tapeworm directly take in predigested food of the host. They have no digestive system of their own.

A peculiar type of digestion is seen in spiders. They inject certain liquids known as *enzymes* into the bodies of living animals such as flies which get caught in their webs. These enzymes dissolve the body of the prey and the liquid is then sucked in by the spider in digested form. Thus digestion in this case occurs outside the body of the animal.

Enzymes

Enzymes are certain body fluids which help in digestion of food. They are secreted on to the food. They act as biological catalysts and accelerate the chemical reactions involved in simplification of the complex food molecules. They are specific in nature, i.e. an enzyme acts only on a particular food. Thus the carbohydrate digesting enzyme acts only on carbohydrates, and not on proteins or fats.

Nutrition in Protozoans

Protozoans prey upon parts of other organisms or organisms smaller than or equal to their own size. In amoeba (Fig. 17.1), the pseudopodia help in catching the prey. The food is taken in through the cell surface and digested in food vacuoles by means of enzymes coming from the endoplasm. The digested food diffuses into the endoplasm, and the undigested portion is discharged. Digestion is intracellular.

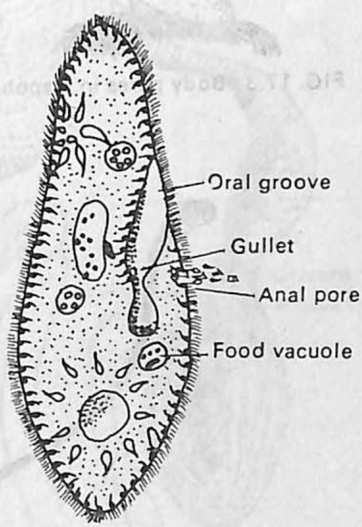


FIG. 17.2 Paramoecium

In paramoecium (Fig. 17.2), the food is pushed into the *oral groove* from where it passes to the *gullet*. At the end of the gullet a food vacuole is formed. Digestion is similar to that in amoeba. The undigested food is thrown out of the *anal pore*.

Thus, in protozoans, the processes of ingestion, digestion, absorption and egestion of food take place from the cell itself. There are no special separate parts for these purposes. In higher animals, however, there are definite structures for carrying out these processes. These structures together make up the *alimentary canal.*

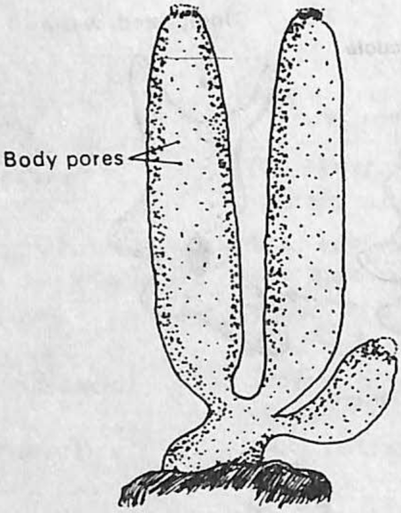
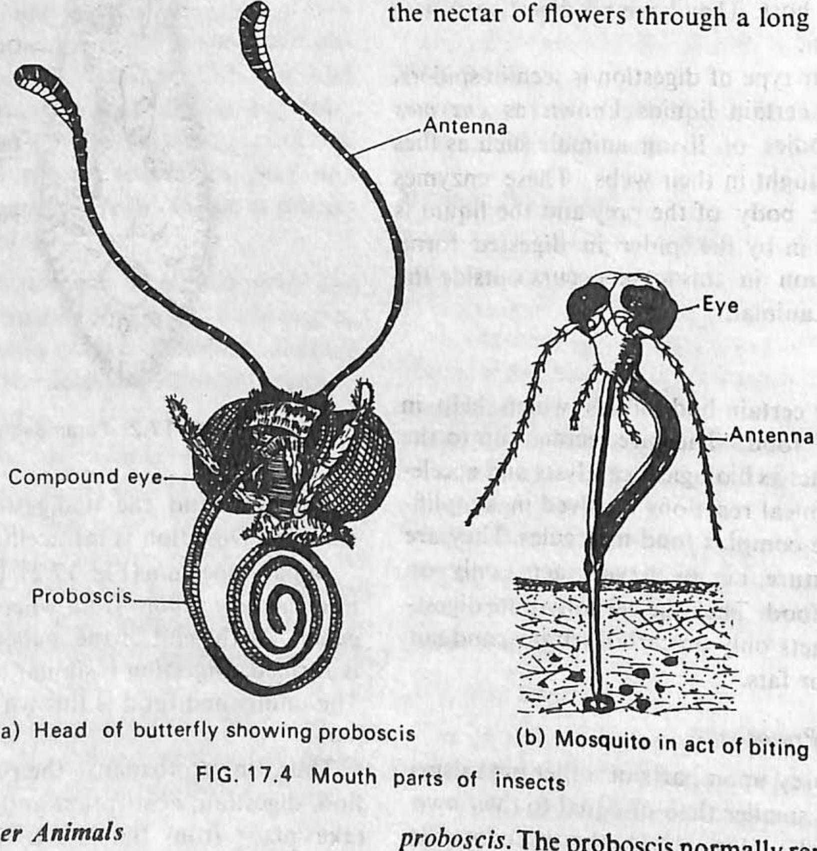


FIG. 17.3 Body pores in a sponge



(a) Head of butterfly showing proboscis (b) Mosquito in act of biting

FIG. 17.4 Mouth parts of insects

Nutrition in Higher Animals

The digestive system in insects and vertebrates has the following important functional regions. These, however, show striking adaptations to the feeding habits and the nature of food.

1. THE REGION OF RECEPTION

This includes the mouth and its associate structures such as the teeth, the tongue and the mouth cavity. This region helps in selecting the food by its smell and taste and in *masticating*, i.e. chewing and grinding it. The mouth cavity also contains the *salivary glands* that secrete *saliva*. It is a digestive juice that contains enzymes for digesting starch. It also helps to lubricate the food.

Very interesting adaptations to the feeding habits are found in this region.

Sponges have a number of body pores (Fig. 17.3). Food particles carried by water currents enter the cavity through these pores and are then engulfed by the cells.

Insects have biting, piercing or sucking type of mouth parts. The *butterfly* (Fig. 17.4) sucks the nectar of flowers through a long tube called *proboscis*. The proboscis normally remains coiled. and straightens when the butterfly sucks nectar. Ectoparasites such as *bed-bugs*, *lice* and *mosquitoes* (Fig. 17.4b) have piercing and sucking type of mouth parts. They suck the blood of host animals. They produce an *anti-coagulant* which prevents the clotting of the host's blood when it is being sucked.

2. THE REGION OF CONDUCTION

The mouth opens into the *oesophagus* (or *gullet*). In some animals this widens to form the *crop* (Fig. 17.5, 17.6). This region conducts the food from the mouth to the region where it is digested.

In some animals, e.g. birbs, this region is used for storage of food as well.

3. THE REGION OF INTERNAL GRINDING AND DIGESTION

From the region of conduction the food passes into the region where it is digested. This region is also adapted according to the food intake.

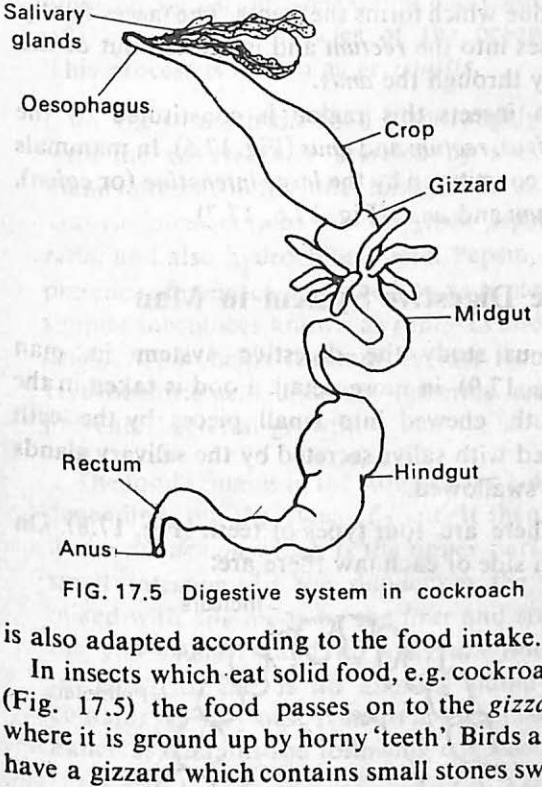


FIG. 17.5 Digestive system in cockroach

In insects which eat solid food, e.g. cockroach (Fig. 17.5) the food passes on to the *gizzard* where it is ground up by horny 'teeth'. Birds also have a gizzard which contains small stones swallowed by the birds (Fig. 17.6). These stones help in grinding the food. This is why domestic birds and poultry should always be supplied with small stones or grit. Insects with sucking mouth parts take in liquid food and the gizzard is either absent or does not have teeth.

In animals, the food is conducted into the *stomach* (Fig. 17.7). Here various enzymes act on the food and digest it.

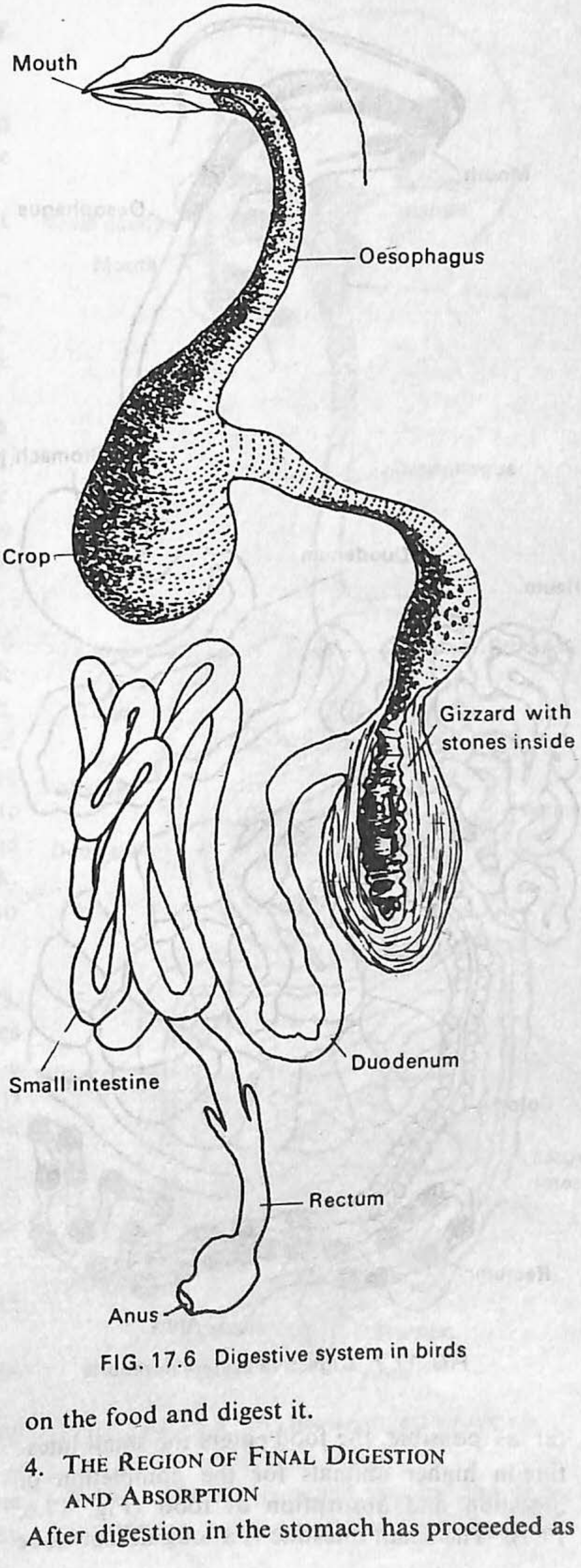


FIG. 17.6 Digestive system in birds

4. THE REGION OF FINAL DIGESTION AND ABSORPTION

After digestion in the stomach has proceeded as

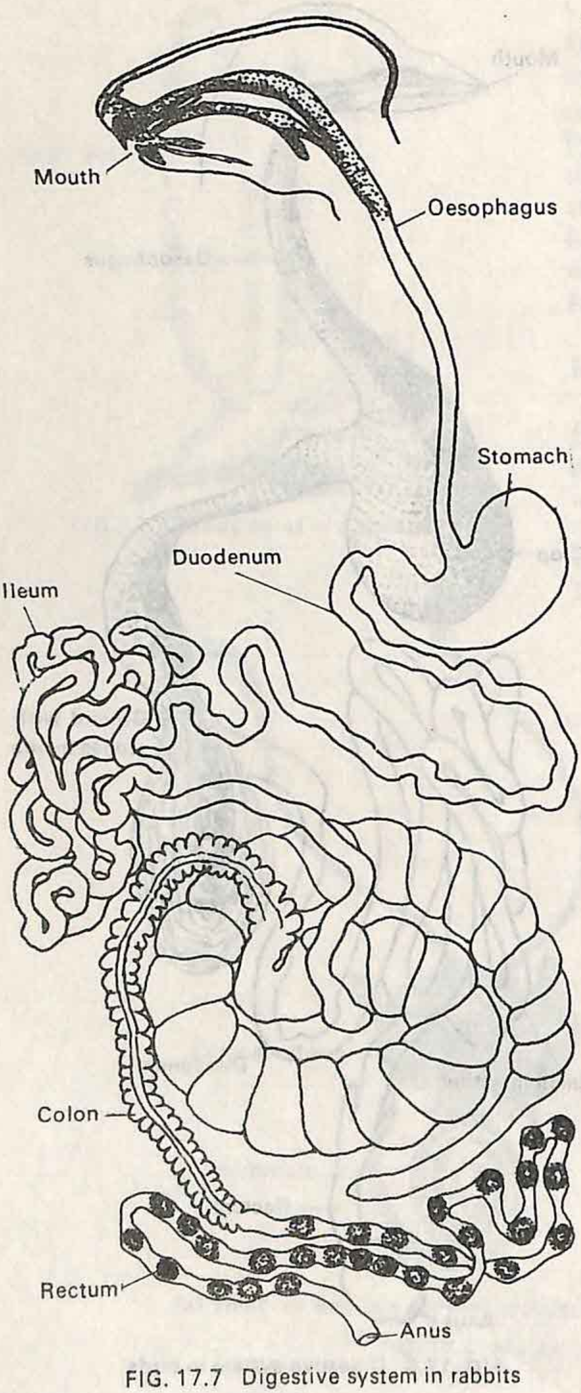


FIG. 17.7 Digestive system in rabbits

far as possible, the food enters the small intestine in higher animals for the completion of digestion and absorption of food (Fig. 17.6, 17.7). The small intestine is a long narrow tube arranged in loops. The initial part of the small intestine is called the *duodenum*. It is about 30 cm long. The rest of the intestine is called the *ileum*. Various enzymes help in final digestion of the food which is then absorbed through the lining of the ileum.

In insects the food from the gizzard enters the *midgut* or *mesenteron* (Fig. 17.5) where digestion is completed and absorption of the digested food takes place.

5. THE REGION OF FAECES FORMATION

In this last region of the alimentary canal, excess water is absorbed and the unabsorbed residue becomes more solid as it passes along. The mucus secreted in this region lubricates the residue which forms the faeces. The faeces finally passes into the *rectum* and is egested out of the body through the *anus*.

In insects this region is constituted by the *hindgut*, *rectum* and *anus* (Fig. 17.5). In mammals it is constituted by the *large intenstine* (or *colon*), *rectum* and *anus* (Fig. 17.6, 17.7).

The Digestive System in Man

Let us study the digestive system in man (Fig. 17.9) in more detail. Food is taken in the mouth, chewed into small pieces by the teeth mixed with saliva secreted by the salivary glands and swallowed.

There are four types of teeth (Fig. 17.8). On each side of each jaw there are:

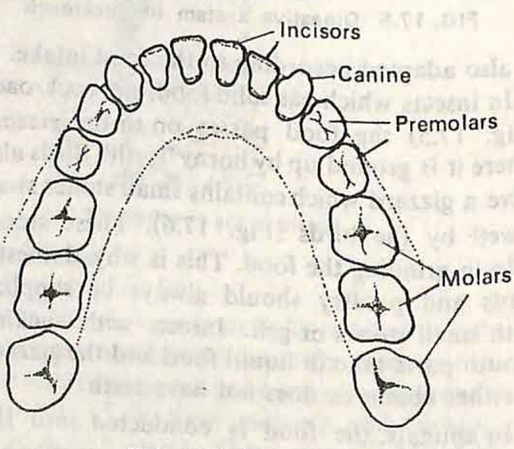


FIG. 17.8 Human teeth

(a) Two sharp-edged *incisors* used for cutting the food.
(b) One pointed *canine* which tears the food.
(c) Two *premolars*, which are broader and have two points at the top which crush the food.
(d) Three broad *molars* with four points at the top which grind the food.

Saliva contains the enzyme *ptyalin* which converts starch to a simpler compound called *maltose*. Saliva also lubricates the food, making it easier to swallow.

The *tongue* helps in rolling and pushing the food into the *pharynx*. From here the food enters the *oesophagus* and moves towards the *stomach* by periodic relaxation and contraction of the inner wall muscles of the oesophagus. This process is known as *peristalsis*.

In the stomach the food is thoroughly mixed with the *gastric juice* secreted by the gastric glands present in the inner lining of the stomach. Gastric juice contains the enzymes *pepsin* and *renin* and also hydrochloric acid. Pepsin, in the presence of hydrochloric acid breaks proteins into simpler substances known as *peptones* and *amino acids*. *Renin* helps to emulsify fats from milk. Hydrochloric acid dissolves minerals and also prevents bacterial growth.

The food remains in the stomach for 1-4 hours, depending on the type of food. It then moves to the *duodenum* which is the upper part of the small intestine. In the duodenum the food is mixed with *bile* made by the *liver* and stored in the *gall bladder*, and the *pancreatic juice* from the *pancreas*. Bile is an alkaline liquid which contains no enzymes. It helps in digestion of fat. Pancreas contains the following enzymes.

(a) *Trypsin* which acts on proteins producing peptones.
(b) *Amylase* which acts on starch producing maltose.
(c) *Lipase* which acts on fat, producing glycerol and fatty acids.

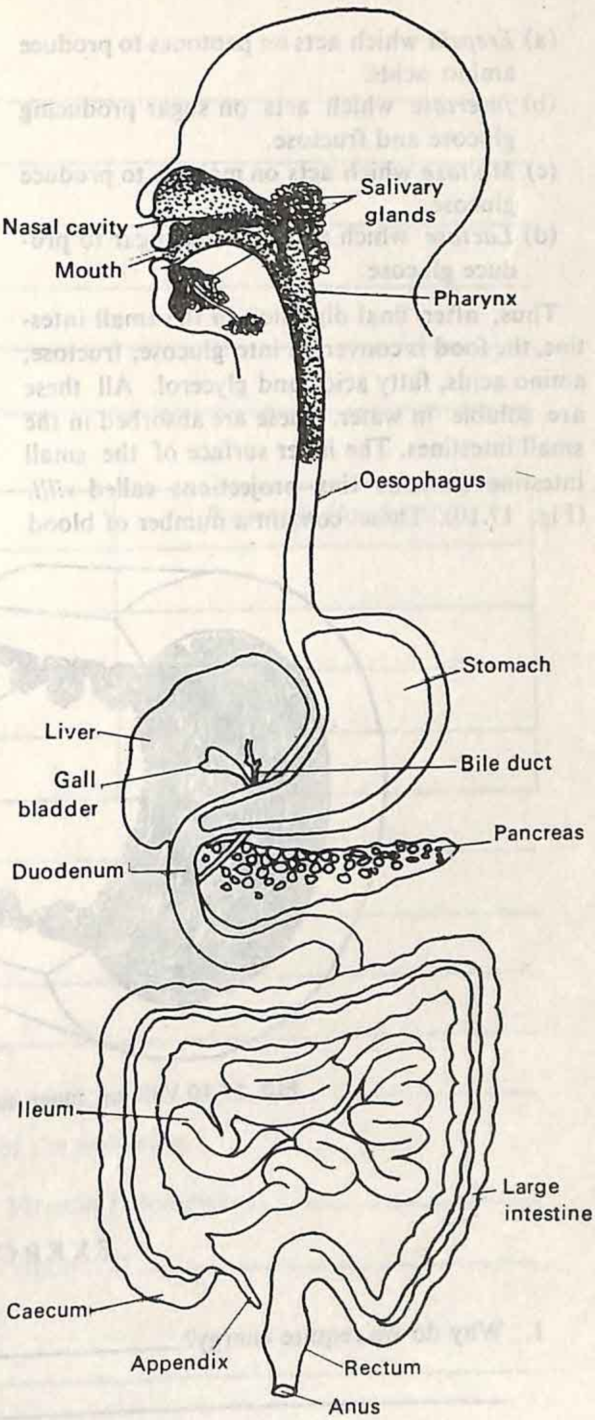


FIG. 17.9 The human digestive system

From the duodenum the food passes on to the lower part of the small intestine, known as the *ileum*. Here it is acted on by the following enzymes.

(a) *Erepsin* which acts on peptones to produce amino acids.
(b) *Invertase* which acts on sugar producing glucose and fructose.
(c) *Maltase* which acts on maltose to produce glucose.
(d) *Lactase* which acts on milk sugar to produce glucose.

Thus, after final digestion in the small intestine, the food is converted into glucose, fructose, amino acids, fatty acids and glycerol. All these are soluble in water. These are absorbed in the small intestines. The inner surface of the small intestine contains tiny projections called *villi*. (Fig. 17.10). These contain a number of blood capillaries surrounding lymph vessels called *lacteal*. Simple sugars and amino acids are absorbed in the blood capillaries. Fatty acids and glycerol enter the lymph vessels and pass on to blood vessels. They are then taken to all parts of the body for absorption by the cells.

Vitamins and minerals do not need to be digested and are absorbed as such.

The undigested residue which mainly contains cellulose, now moves on to the large intestine. Here water is absorbed and the solid residue lubricated with mucus to form the faeces. The faeces passes to the rectum and is then expelled from the body through the anus.

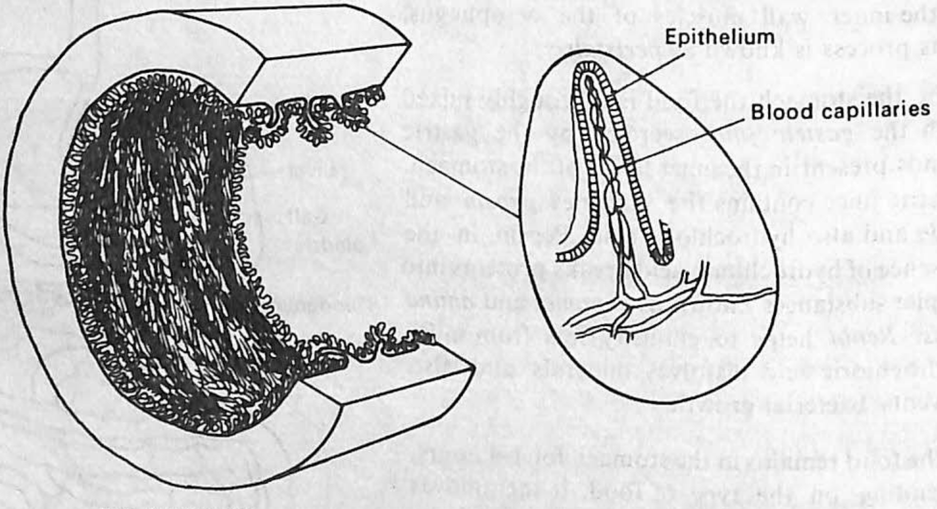


FIG. 17.10 Villi on inner surface of small intestine

EXERCISES

1. Why do we require energy? ______________________________

____

____

____

____

2. Explain the following.

(a) Herbivores ______________________________

(b) Carnivores ______________________________

(c) Omnivores ______________________________

3. Complete the following table.

Nutrient	*Function*	*Present in* (foodstuffs)
Carbohydrates		
Proteins		
Fats		
Minerals		

4. Why does the body need water? ______________________________

5. Mention the deficiency disease caused by lack of the following.

Vitamin A ______________ Vitamin B complex ______________

Vitamin C ______________ Vitamin D ______________

Which vitamins are contained in the following?

Milk ______________________________

Egg ______________________________

Green vegetables ______________________________

6. Nutrition in animals involves four main process. Name the processes. ______________

7. What is digestion.

8. In which animals do you observe intracellular digestion? How does nutrition in these animals differ from that in higher animals?

9. What are enzymes?

10. Name the important functional regions in the alimentary canal of higher animals.

11. How is the mouth of a butterfly adapted to suit its feeding habits?

12. Why should domestic birds and poultry always be supplied with small stones?

13. Where is saliva secreted? What are its functions?

14. In which parts of the body does the food get digested in mammals? In which part is the digested food absorbed?

15. What is the main function of the large intestine in mammals and the hindgut in insects?

16. How do spiders digest their food?

17. Do tapeworms have an alimentary canal? Why?

18. Name the types of teeth possessed by an adult man and give their function.

19. Where do you find the following enzymes? What are their functions?

Ptyalin

Trypsin

Pepsin

Renin

Erepsin

Maltase

20. Explain the process of absorption of food in the small intestine.

18

Respiration in Animals

We have seen earlier that food is the source of energy for carrying out various life processes by the body. However, the food absorbed by cells has to be first converted into kinetic energy to enable it to be used by the body. This is done in the cells. The digested food absorbed by the cells is broken down by making use of oxygen, and energy is released. This process is known as *respiration*. Respiration is actually slow burning or *oxidation* of food, which in most cases is glucose, to release energy and liberate carbon dioxide and water.

$$\text{glucose} + \text{oxygen} \xrightarrow{\text{respiration}} \text{carbon dioxide} + \text{water} + \text{energy}$$

The oxygen necessary for respiration is taken from the air we breathe in or *inhale*. The carbon dioxide and water vapour produced are got rid of when be breathe out or *exhale*. The exhaled air therefore contains a greater proportion of carbon dioxide and water vapour and less of oxygen than the inhaled air. As energy is continuously needed by the body for carrying out various life processes, respiration is a continuous process. In fact it is not possible for us to stay alive for more than 2-3 minutes without breathing.

Respiration is carried out in two steps.

(i) *External respiration* is the breathing in of oxygen of the air and the breathing out of carbon dioxide.

(ii) *Internal respiration* involves exchange of gases with the cell where oxygen is used up and carbon dioxide is released along with water and energy.

Experiment 1

To show that exhaled air contains an increased proportion of carbon dioxide.

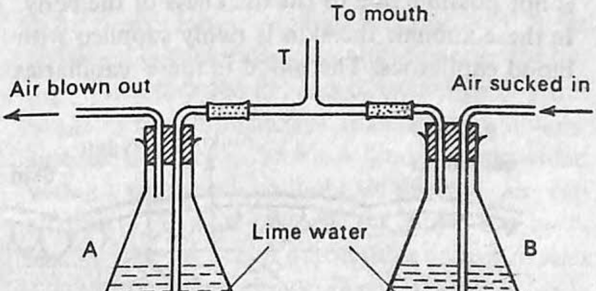


FIG. 18.1 Exhaled air contains more carbon dioxide than inhaled air

Take lime water in two flasks and set up the apparatus as shown in Fig. 18.1. Suck in air from the tube T. The air enters your mouth through the lime water in flask B. Now blow out air, which will bubble through the flask A. After sucking in and out a few times you will notice that the lime water in flask A turns milky whereas that in flask B remains clear.

This shows that the exhaled air has a greater proportion of carbon dioxide than the inhaled air.

Respiratory Devices

SKIN BREATHERS

In some animals the oxygen supply is obtained through the body surface. This occurs in small animals such as protozoans (e.g. amoeba) or in larger animals having thin and moist skin such as earthworm or frog. In amoeba (Fig.18.2) the oxygen directly diffuses inside the cell. In animals such as the earthworm (Fig.18.3) however, this is not possible due to the thickness of the body. In these animals the skin is richly supplied with blood capillaries. The blood in these capillaries absorbs oxygen and gives out carbon dioxide. The oxygen is distributed by the blood to cells of various organs.

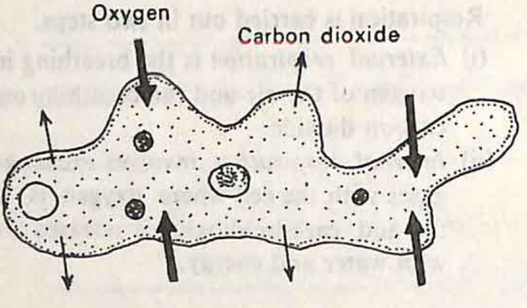


FIG. 18.2 Breathing in amoeba

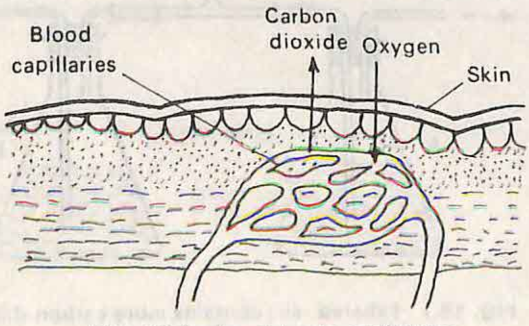


FIG. 18.3 Breathing in earthworm

GILL BREATHERS

Many animals living in water, such as prawn and fish, have organs known as *gills* for respiration (Fig.18.4). Gills are made up of a large number of filaments richly supplied with blood capillaries. The fish takes in water through the mouth, which passes through the gills, where exchange of gases between water and the gills takes place.

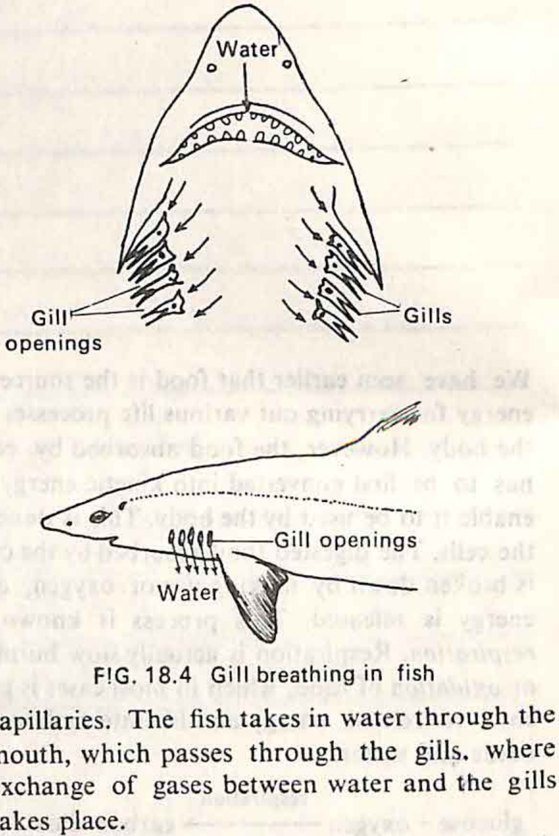


FIG. 18.4 Gill breathing in fish

Gills are not suited for respiration in air. This is why a fish dies when taken out of the water.

AIR-TUBE BREATHERS

Insects such as cockroaches and some spiders have bodies full of a large number of interconnected small tubes known as *trachea*. These open outside through small pores called *spiracles* on the surface of the insect (Fig.18.5). The air enters the body through these spiracles and is distributed throughout the body by the trachea, which divide and subdivide into smaller tubes called *tracheoles*. In these insects the air is

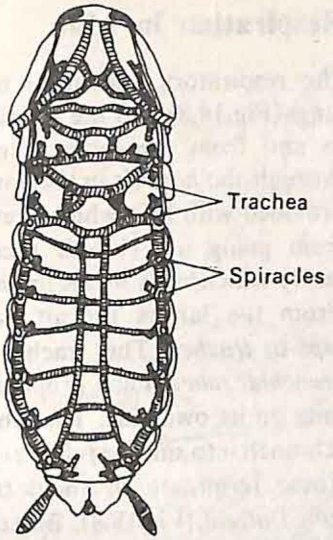
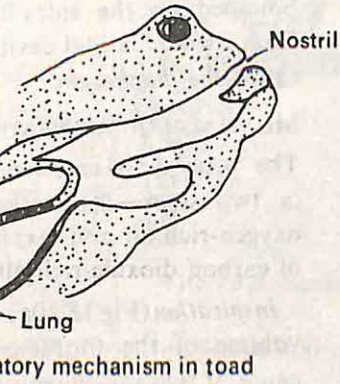
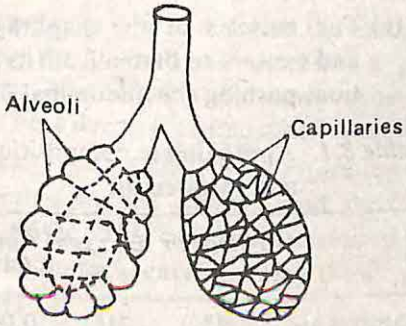


FIG. 18.5 Tracheal system in cockroach

carried directly to the cells and blood capillaries are not necessary. Carbon dioxide from the cells leaves the body through the tracheae and spiracles.



(a) Respiratory mechanism in toad



Left lung showing alveolar structure

Right lung showing blood capillaries

(b) Lungs of the toad

FIG. 18.6

LUNG BREATHERS

In most land vertebrates the need of oxygen is greater and cannot be met by the means explained above. Hence such animals are provided with special respiratory organs called *lungs*.

In *amphibians*, such as frogs and toads, the lungs are two sac-like structures with elastic walls (Fig.18.6). Each lung is divided into a number of thin walled chambers called *alveoli*. The walls of these alveoli have a network of capillaries. The exchange of gases takes place in the alveoli.

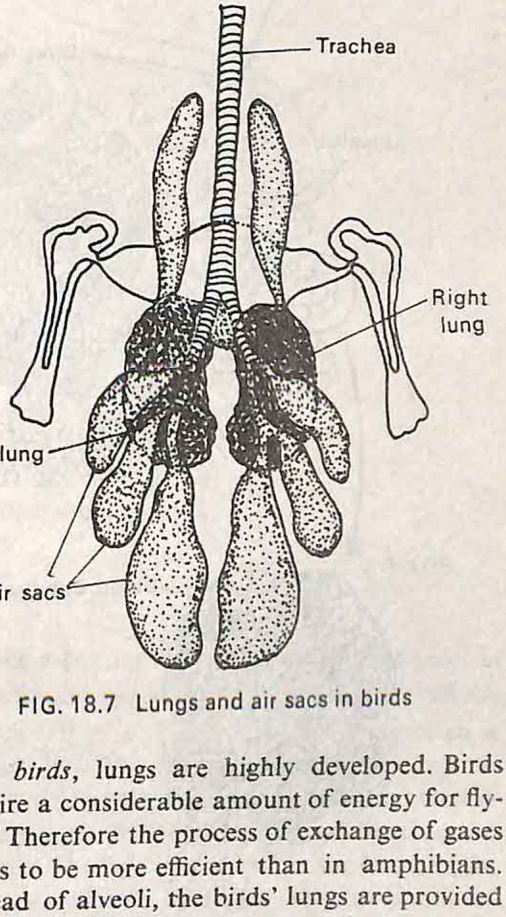


FIG. 18.7 Lungs and air sacs in birds

In *birds*, lungs are highly developed. Birds require a considerable amount of energy for flying. Therefore the process of exchange of gases needs to be more efficient than in amphibians. Instead of alveoli, the birds' lungs are provided with air capillaries so that atmospheric air can efficiently circulate through the lungs. The lungs lead to non-respiratory structures called *air sacs* (Fig.18.7) which store air. These air sacs provide buoyancy to the birds for flying.

In *mammals* also the lung is divided into *alveoli* but the alveolar structure is more compli-

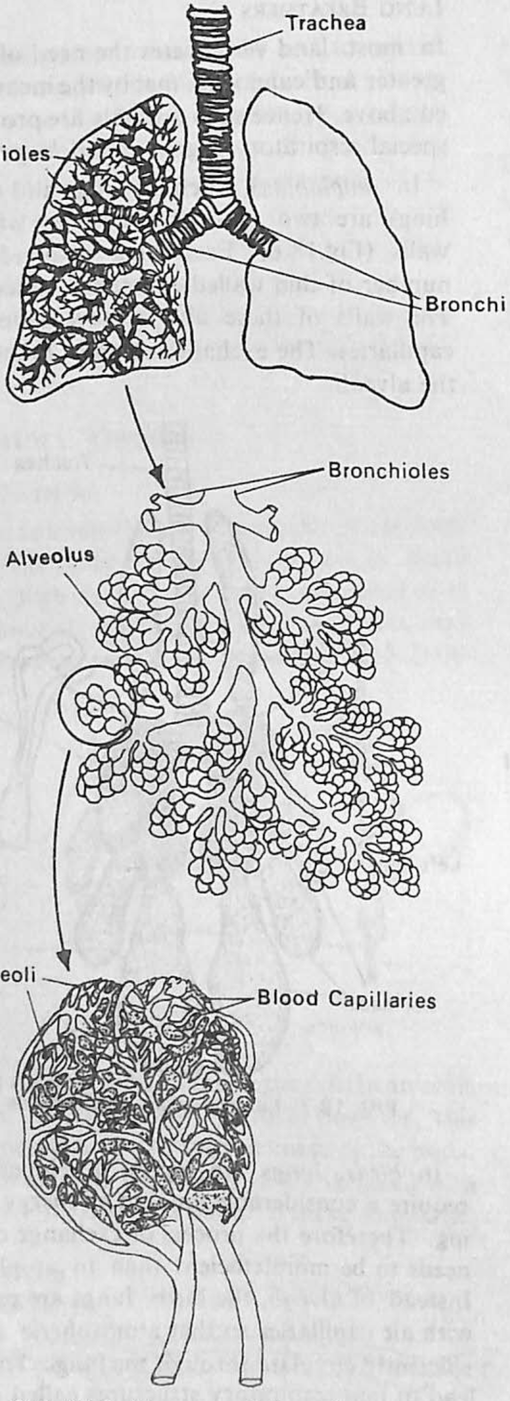


FIG. 18.8 Structure of lungs in mammals

cated for more efficient exchange of gases. The walls of the alveoli are well supplied with blood capillaries (Fig.18.8).

Respiration in Man

The respiratory systems in man consists of the lungs(Fig.18.8) and the passage which carry air to and from the lungs (Fig.18.9). Air enters through the *nostrils* in the nose. The nostrils are provided with hair which prevent dust particles from going in. The air then enters the *nasal cavity* which leads to the *larynx* or the voice box. From the larynx the air passes into the *wind pipe* or *trachea*. The trachea divides into two *bronchial tubes*. Each bronchial tube leads to the lung on its own side. The tubes then branch and rebranch into smaller tubes known as *bronchioles*. These terminate in small thin-walled air sacs called *alveoli*(Fig.18.8). Blood capillaries form a network around the alveoli (Fig.18.8). Oxygen from the air sacs is absorbed by the blood in the capillaries and carbon dioxide in the blood enters the air sacs.

The lungs occupy the major part of the chest cavity known as the *thoracic cavity*. This is bounded on the sides by *ribs* and is separated from the abdominal cavity by a muscular wall called the *diaphragm*.

MECHANISM OF RESPIRATION

The process of external respiration takes place in two steps—*inspiration* or breathing in of oxygen-rich air and *expiration* or breathing out of carbon dioxide-rich air.

Inspiration (Fig.18.10a): During inspiration the volume of the thoracic cavity is increased because of two movements.

(a) The muscles of the diaphragm contract and cause it to flatten from its domed position, pushing the abdominal organs down.

Table 8.1: Approximate composition of expired and inspired air

	Nitrogen	*Oxygen*	*Carbon dioxide*	*Water vapour*
Inspired air	79%	21%	0.04%	Variable
Expired air	79%	16%	4%	Saturated

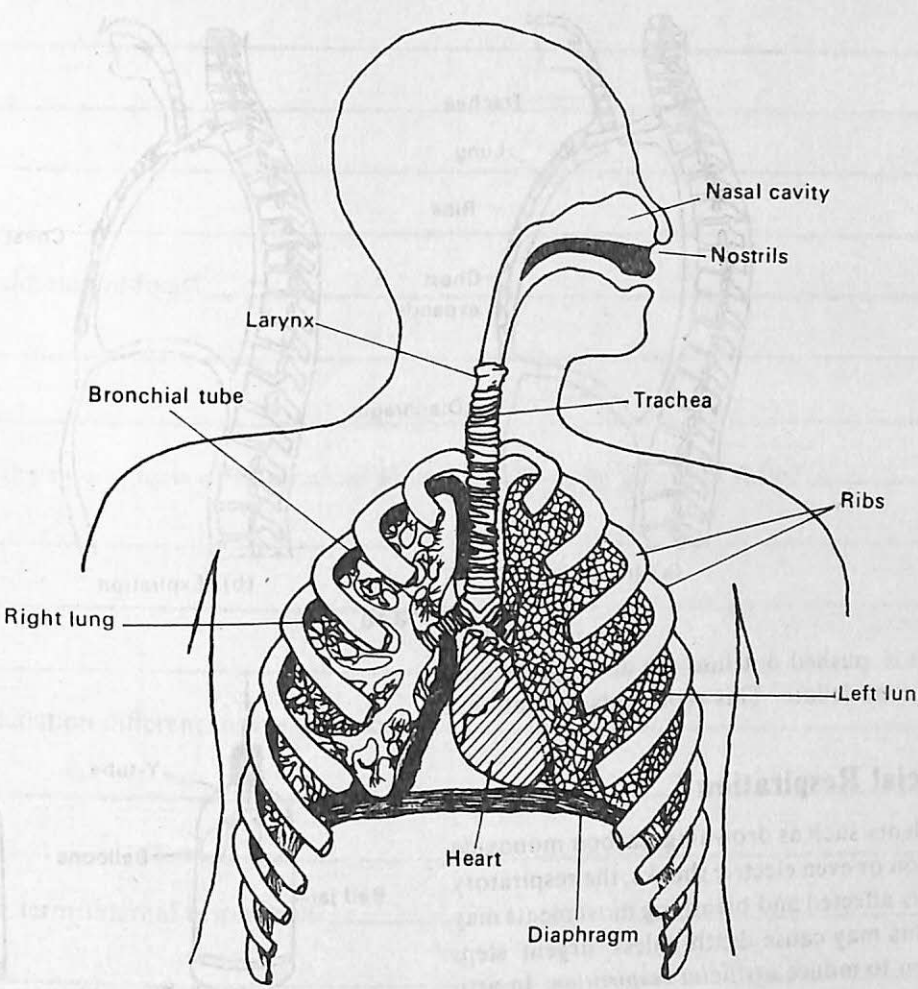


FIG. 18.9 Respiratory system in man

(b) The lower ribs are raised upwards and outwards by the rib muscles.

This increase in the volume of the thoracic cavity causes the lungs to swell, creating a partial vacuum. The outside air now rushes in through the nose due to the atmospheric pressure.

Expiration (Fig. 18.10b) During expiration the ribs are lowered by the muscles and the diaphragm is raised. This causes a decrease in the volume of the thoracic cavity forcing the air out of the lungs.

Table 18.1 gives the approximate composition of inspired and expired air.

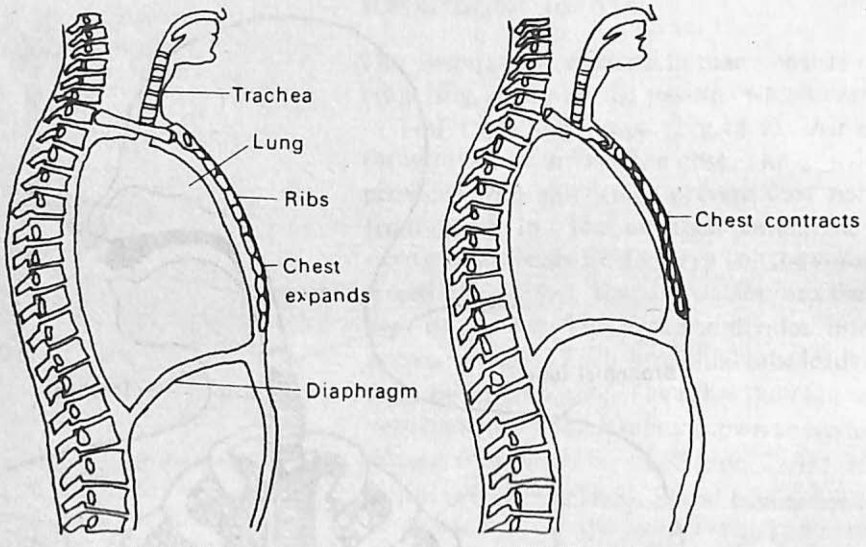
Experiment 2

To demonstrate lung respiration by a model.

Take a bell jar and tie a thin rubber sheet at the wide end as shown in Fig. 18.11. Fix a balloon at each end of a Y-tube and fix it through a stopper into the jar as shown. The sheet of rubber represents the diaphragm. The pressure in the jar can be varied by pushing the sheet up or down. The balloons represent the lungs which inflate or deflate according to the movement of the rubber sheet.

Pull the rubber sheet down (Fig. 18.11a). This increases the volume of the jar, causing air to rush in and inflate the balloons. This represents inhalation.

Push the rubber sheet into the jar (Fig. 18.11b). The volume of the jar decreases. The air in the



(a) Inspiration (b) Expiration

FIG. 18.10

balloons is pushed out into the atmosphere and the balloons deflate. This represents expiration.

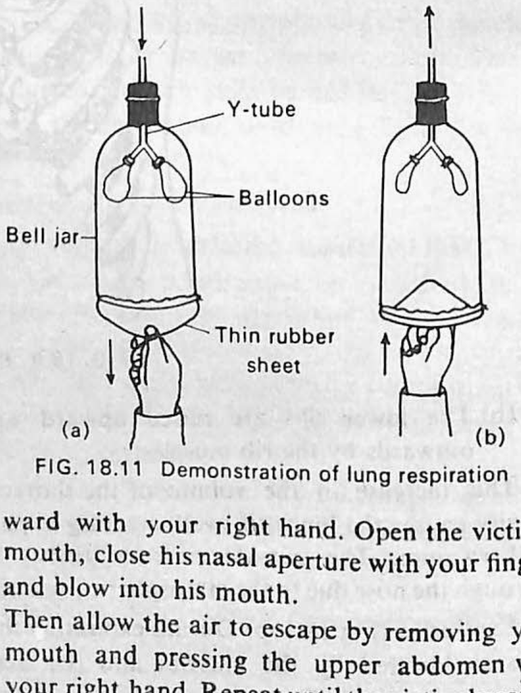


FIG. 18.11 Demonstration of lung respiration

Artificial Respiration

In accidents such as drowning, carbon monoxide inhalation or even electric shocks, the respiratory system is affected and breathing movements may stop. This may cause death unless urgent steps are taken to induce *artificial respiration*. In artificial respiration, expansion and contraction of the lungs is done artificially, causing flow of air in and out of the lungs. This should be continued until normal breathing is restored. One of the methods for giving artificial respiration is as follows.

MOUTH TO MOUTH METHOD

In this method the lungs of the victim are expanded by the operator's breath.

Make the victim lie on his back with neck extended. Draw the lower jaw upwards and forward with your right hand. Open the victim's mouth, close his nasal aperture with your fingers and blow into his mouth.

Then allow the air to escape by removing your mouth and pressing the upper abdomen with your right hand. Repeat until the victim breathes by himself.

EXERCISES

1. What is respiration? Why should it take place continuously? ______

2. What is oxidation of food?

3. What are the by-products of respiration? How does the body get rid of them?

4. How is inhalation different from exhalation?

5. Explain the term internal respiration.

6. How do amoebae respire?

7. Name two animals that breathe through the skin.

8. Which animals respire with the help of gills?

9. Why are blood capillaries not necessary in air-tube breathers?

10. Why do higher animals such as birds and mammals have lungs for respiration?

11. How are the lungs of amphibians different from those in mammals?

12. How do air sacs help birds?

13. Explain the following terms.

Bronchial tube

Alveoli

Inspiration

Expiration

14. What is the diaphragm? Explain its importance in inspiration and expiration.

15. When is artificial respiration necessary? What is the principle of artificial respiration?

19

The Human Body

A cell is a simple form of life capable of digestion, respiration, excretion, reproduction and other life processes. A man is a complex form of life with billions of cells in his body. These cells are organized in such a way that each cell performs a specialized function. The human body, in fact, is a highly organized 'machine' containing several systems for carrying out various life processes. Each system consists of a number of organs which carry out particular functions. Each organ in turn is made up of specialized cells and tissues. We have already studied about two vital systems in our body—the digestive system and the respiratory system. Let us study, in brief, about the other systems and organs in our bodies.

Body Form

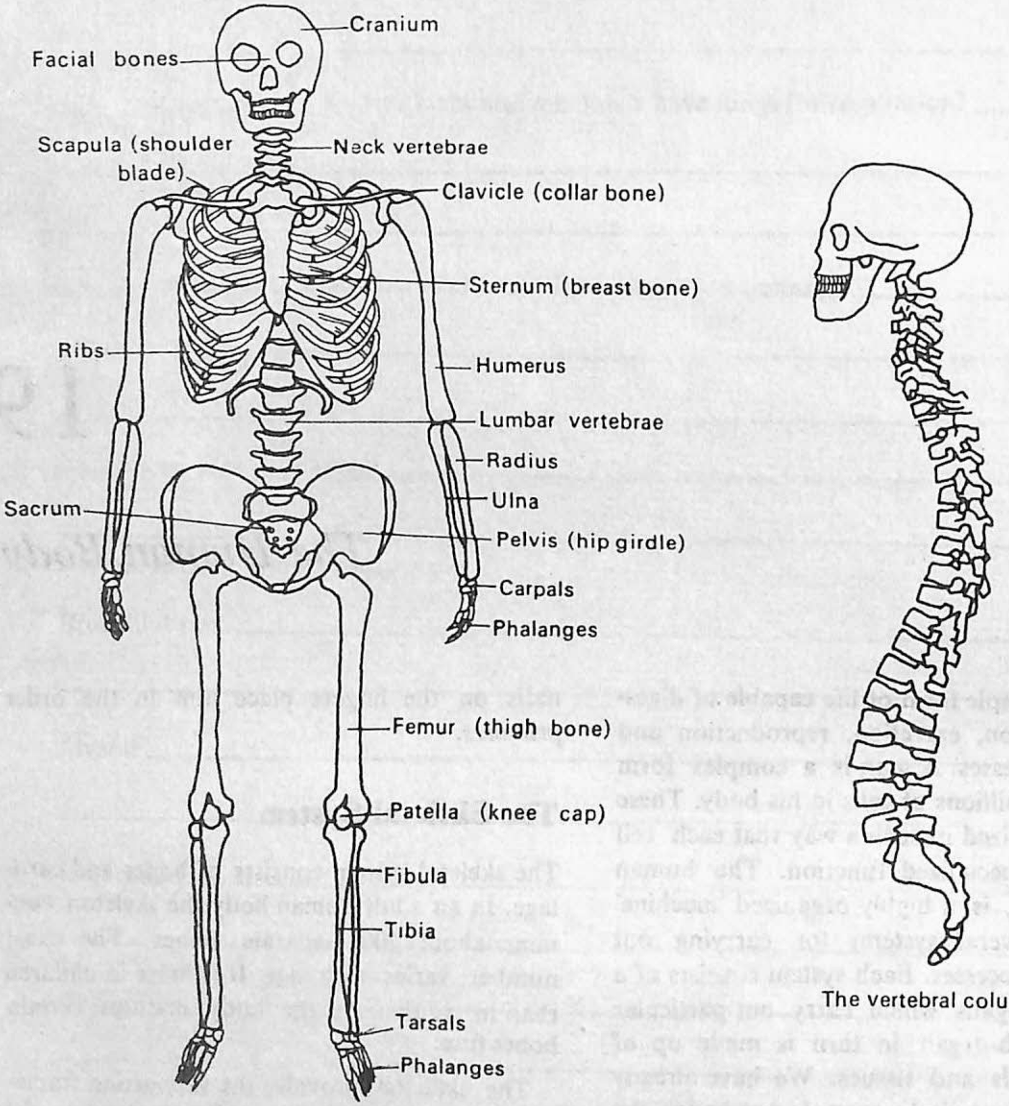
Man is a vertebrate animal, with a well developed vertebral column (Fig. 19.1) consisting of a chain of small bones called *vertebrae*. The body has two appendages—forearms and hind limbs. The presence of hair and mammary glands place man in the class of *mammals*. Highly developed and large brain, the eyes directed forwards, and nails on the fingers place him in the order *primates*.

The Skeletal System

The skeletal system consists of bones and cartilage. In an adult human body the skeleton contains about 200 separate bones. The exact number varies with age. It is more in children than in adults. As the body matures certain bones fuse.

The skeleton provides the supporting framework of the body and protects the internal organs. The skull protects the brain, the rib cage protects the heart and lungs and the *vertebral column* protects the spinal cord. The vertebral column contains 33 bones and is the main support of the skeleton. The skeleton also consists of bones of appendages to support hands and legs.

Bones are joined to each other by means of tough connective tissues known as *ligaments*. The joints of bones in the moveable parts of the body such as hands, legs, neck or fingers are such that the bones can easily move over each other. In fact the bones act as levers and magnify



The vertebral column

FIG. 19.1 The human skeleton

the movements caused by the contraction of muscles. This helps in improving the efficiency of locomotion in the body.

Figure 19.1 shows the human skeleton and gives the names of the important bones.

The Circulatory System

The circulatory or transport system helps to transport various substances from one organ to the other, and to exchange substances between tissues and the external environment. The nutritive material from the digestive system are transported to the cells; oxygen is transported from the lungs to the cells and carbon dioxide from the cells to the lungs; the metabolic waste products are transported from the cells to the organs of excretion.

The circulatory system (Fig. 19.2) consists of a pumping organ called the *heart*, the fluid medium called *blood*, and the tubes known as *blood vessels*, which transport the blood.

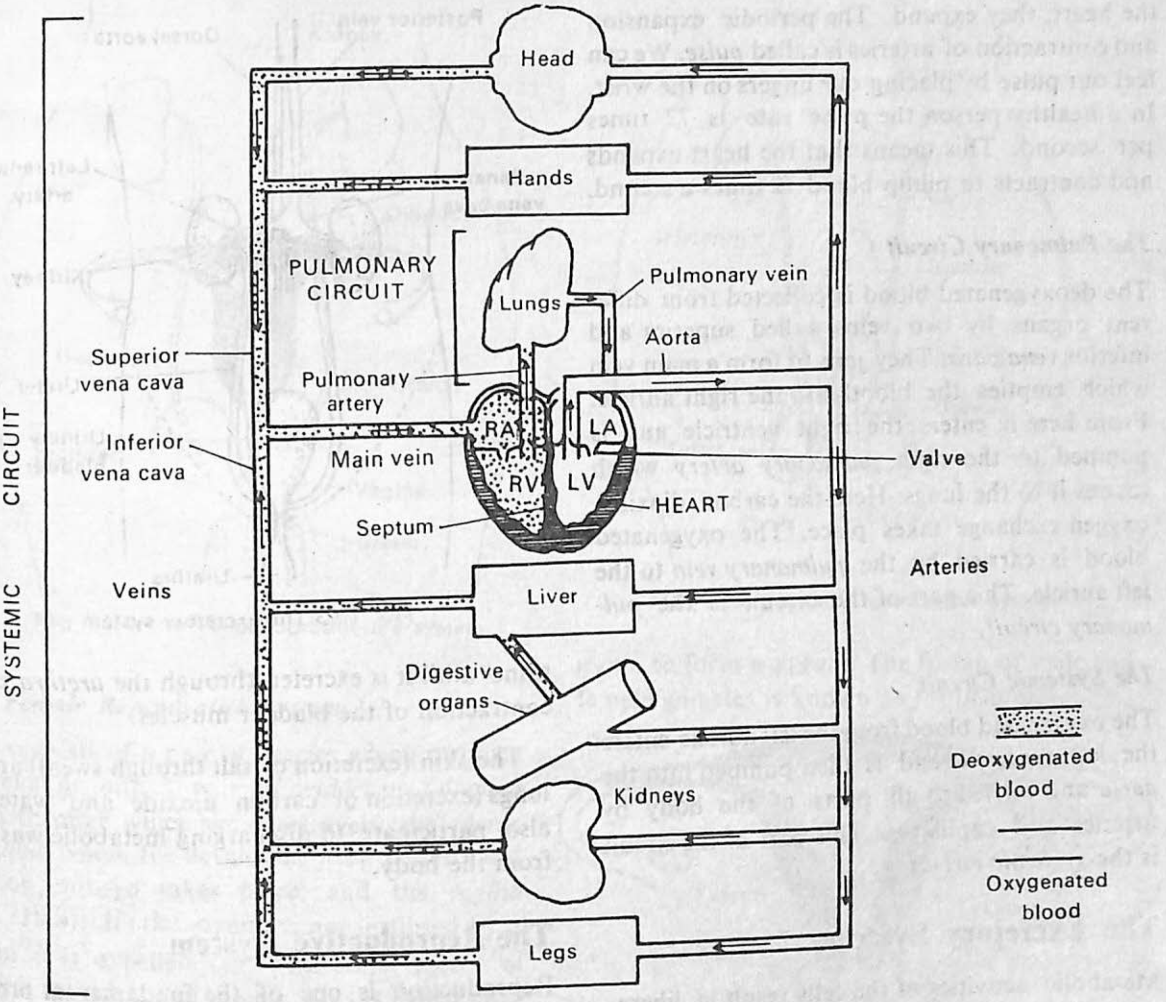


FIG. 19.2 The circulatory system

The Heart

The human heart consists of four chambers, two upper right and left *auricles* and two lower right and left *ventricles*. The left auricle and ventricle contain the oxygen-rich blood, while the right auricle and ventricle contain blood with carbon dioxide. The right and left sides are separated by a wall called *septum*. The valves in the heart help the blood to flow in one direction.

The Blood

The blood consists of the following.

The *red blood corpuscles* (R.B.C.) or *erythrocytes* which are responsible for transporting oxygen to different cells in the body.

White blood corpuscles (W.B.C.) or *leucocytes* which defend the body against harmful bacteria and viruses.

Plasma, the fluid medium, which transports digested food as well as metabolic waste products.

The Blood Vessels

Arteries carry the blood away from the heart to various parts of the body. They divide and subdivide to form smaller arteries. The thinnest arteries which carry blood to individual cells are known as *capillaries*. After having passed through all parts of the body the capillaries converge to from *veins* which carry the blood to the heart. When the blood is pumped into the arteries by the heart, they expand. The periodic expansion and contraction of arteries is called *pulse*. We can feel our pulse by placing our fingers on the wrist. In a healthy person the pulse rate is 72 times per second. This means that the heart expands and contracts to pump blood 72 times a second.

The Pulmonary Circuit

The deoxygenated blood is collected from different organs by two veins called superior and inferior *vena cava*. They join to form a main vein which empties the blood into the right auricle. From here it enters the right ventricle and is pumped to the right *pulmonary artery* which carries it to the lungs. Here the carbon dioxide-oxygen exchange takes place. The oxygenated blood is carried by the *pulmonary vein* to the left auricle. This part of the circuit is the *pulmonary circuit*.

The Systemic Circuit

The oxygenated blood from the left auricle enters the left ventricle and is then pumped into the *aorta* and carried to all parts of the body by arteries and capillaries. This part of the circuit is the *systemic circuit*.

The Excretory System

Metabolic activities of the cells result in liberation of energy and formation of various by-products such as carbon dioxide and ammonia. These must be eliminated from the body or else they become toxic and can kill the cells. The excretory system performs the task of collecting these by-products and removing them from the body. It consists of two *kidneys*, two *ureters*, a *urinary bladder* and a *urethra*(Fig. 19.3).

The kidneys are reddish-brown bean-shaped structures located at the back of the abdominal cavity, one on each side of the vertebral column. The basic units of the kidney are the large number of coiled tubes called *nephrons*. They carry waste material such as excess water and urea from the blood and form the *urine*. From here the urine passes into the *urinary bladder* through tubes called *ureters*. The urinary bladder stores the urine until it is excreted through the *urethra* by contraction of the bladder muscles.

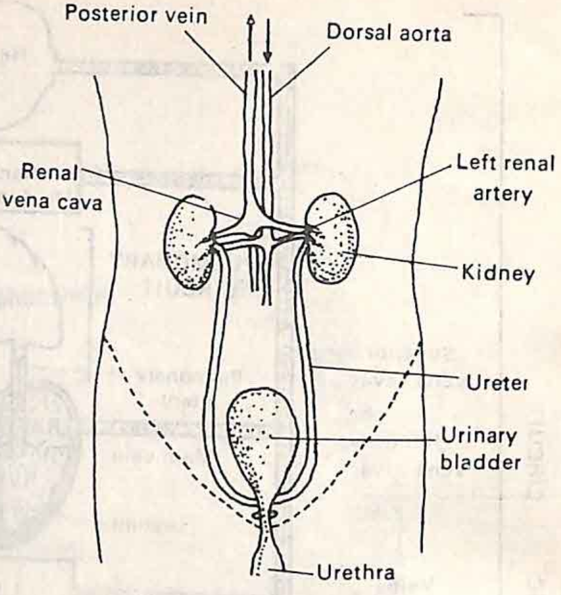


FIG. 19.3 The excretory system

The skin (excretion of salt through sweat) and lungs (excretion of carbon dioxide and water) also participate in discharging metabolic waste from the body.

The Reproductive System

Reproduction is one of the fundamental properties of every living organism, by which it multiplies to form individuals of its own kind. The reproductive system consists of organs in the male and female bodies which produce male and female gametes, the ducts through which they pass, and a chamber in the female where the developing embryo is enclosed until birth.

Although the reproductive organs are present in the human body from birth, they do not become functional until sexual maturity or *puberty* is achieved. Puberty marks the appearance of *secondary sexual characteristics*. In boys the body becomes strong and muscular, hair starts growing on the chin and other parts of the body and the voice cracks. In girls the breasts develop, hair start appearing on different parts of the body, and the *menstrual cycle* begins.

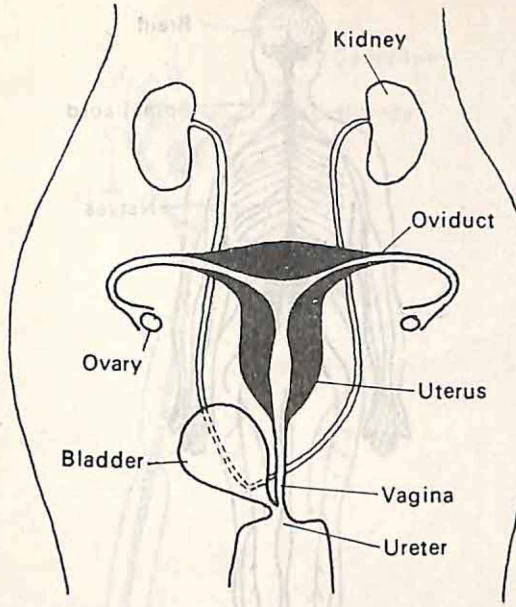


FIG. 19.4 The female reproductive system

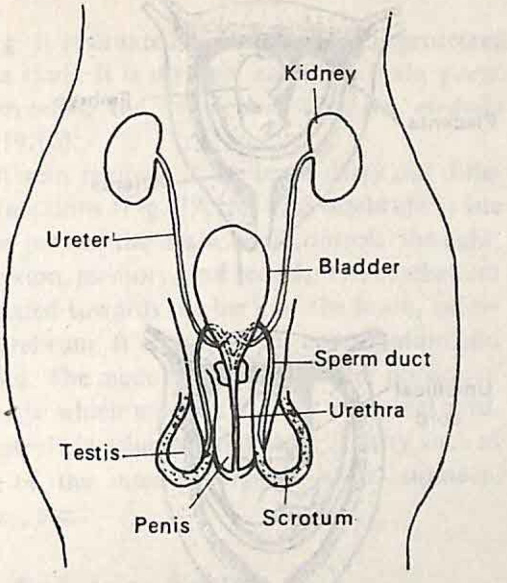


FIG. 19.5 The male reproductive system

The Female Reproductive System

This consists of a pair of *ovaries* which produce the egg or *ova*; a pair of *oviduct* or *fallopian tubes* through which the ova travels; the *uterus* or *womb* where the development of the fertilised egg or embryo takes place; and the *vagina* (Fig. 19.4). If the ovum is not fertilised by a sperm, it is expelled out with some pieces of uterine muscles and blood. This is called *menstruation*.

The Male Reproductive System

This consists of a pair of *testes* enclosed in muscular sacs called *scrotum*. The testes produce the male gametes or *sperms* which are carried out by a pair of *sperm ducts* or *vas deferens* into the *urethra*. At the time of ejaculation from the *penis* they are mixed with a fluid known as *semen* (Fig. 19.5).

Fertilisation

During *copulation* of the male and female, the sperms pass from the penis and enter the vagina. They swim in the semen towards the oviduct (Fig. 19.6). Here a sperm may fuse with the ovum to form a *zygote*. The fusion of male and female gametes is known as *fertilisation*.

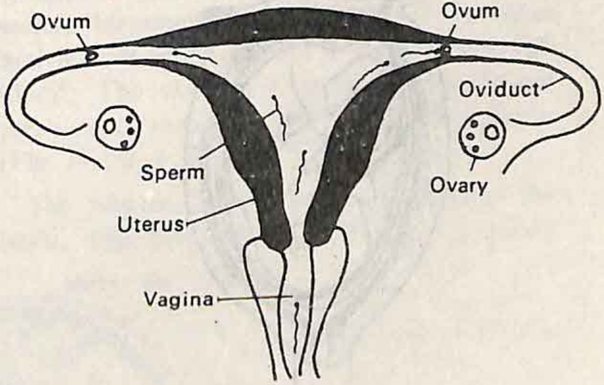


FIG. 19.6 Fertilisation

The zygote enters the uterus and undergoes cell division, obtaining nutrition from the body of the mother through the *placenta*. In the *gestation period* (for human beings this is 266 days) this embryo develops into a human being (Fig. 19.7). Its mass increases to about 3 kg. When it is fully developed, it is forced out of the womb by rhythmic contractions in the walls of the uterus. The *umbilical cord*, which joins the child to the placenta of the mother and through which the child obtains nutrition while in the womb, is cut to separate the mother and child.

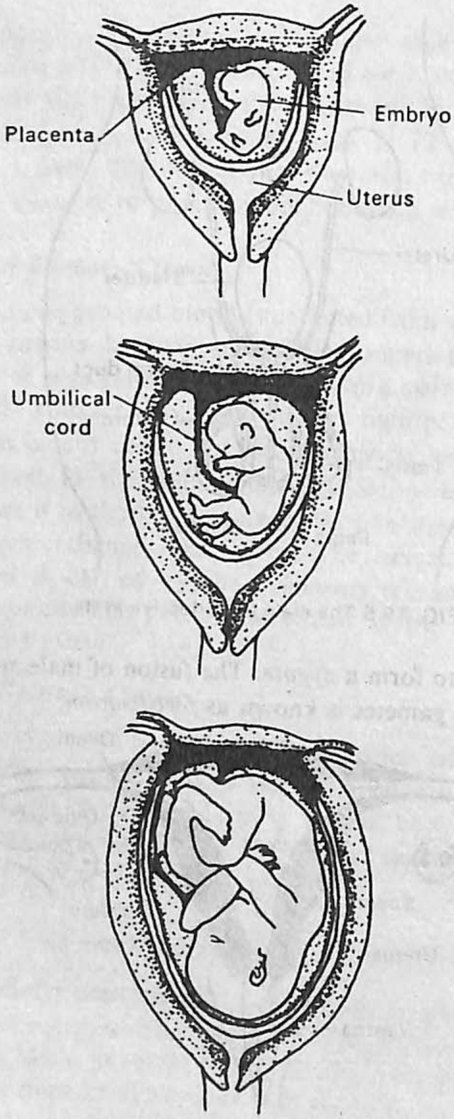


Fig. 19.7 Development of embryo

The Nervous System

The nervous system is constituted by the *brain*, the *spinal cord* and the *nerves* (Fig. 19.8). It can be called the communication network of the body. External or internal messages are received and transmitted round the body by the nervous system. Messages can be sensations sent by the sense organs such as eyes, ears, nose, hands, etc. and commands by the brain to various parts of the body in response to these sensations. For example if your hand touches a very hot body, a sensation of extreme heat passes from the hands to the brain through the nervous system. Immediately the brain sends an order to the hand muscles to contract, causing the hand to move away from the hot body. This entire process takes only three-tenths of a second! Such an action is called a *reflex action*. Nerves that transmit command messages from the brain to various parts of the body are known as *motor nerves*. Those which carry information to the brain from the sensory organs are called *sensory nerves*.

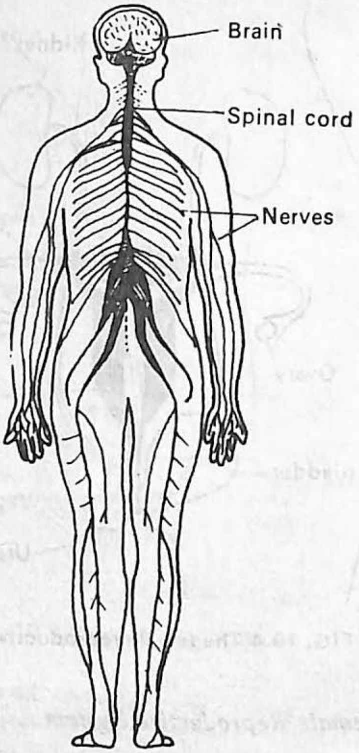


FIG. 19.8 The nervous system

A nerve cell, i.e. a cell that carries impulses, is called a *neuron* (Fig. 19.9). It has a cell body with a nucleus and projections called *dendrites*. The dendrites receive the messages and pass them on to fibres called *axons*. This message reaches the brain through the *spinal cord*. The spinal cord is about 50 cm long and passes down the vertebral column.

The Brain

In a mature human being the brain weighs about

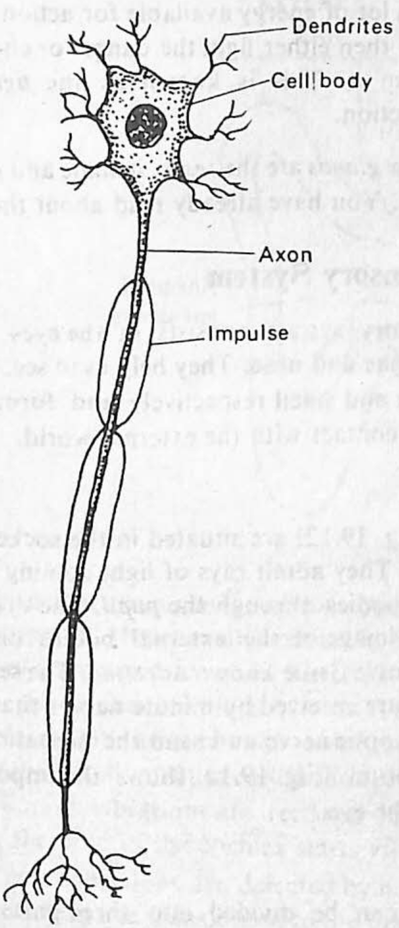


FIG. 19.9 A neuron

1350 g. It is situated in the head and is protected by the skull. It is divided into three main parts: the *cerebrum*, the *cerebellum* and the *medulla* (Fig. 19.10).

Different regions of the brain carry out different functions (Fig. 19.10). The cerebrum is the largest part of the brain and controls thought, perception, memory, and speech. The cerebellum is situated towards the back of the brain, below the cerebrum. It controls body coordination and balance. The medulla forms the lower portion of the brain which narrows to form the spinal cord. It controls involuntary muscular activity such as those of the internal organs--heart, stomach, kidney, etc.

The Endocrine System

This consists of certain glands (a gland is a group of cells that help in secretion) without ducts situated in different parts of the body. They secrete *hormones* which effect growth and other activities. Hormones travel in the body through blood. The important endocrine glands are *pituitary*, *thyroid*, *adrenal* and *sex* glands (Fig. 19.11).

The *pituitary gland* lies at the base of the brain. The hormones secreted by it regulate

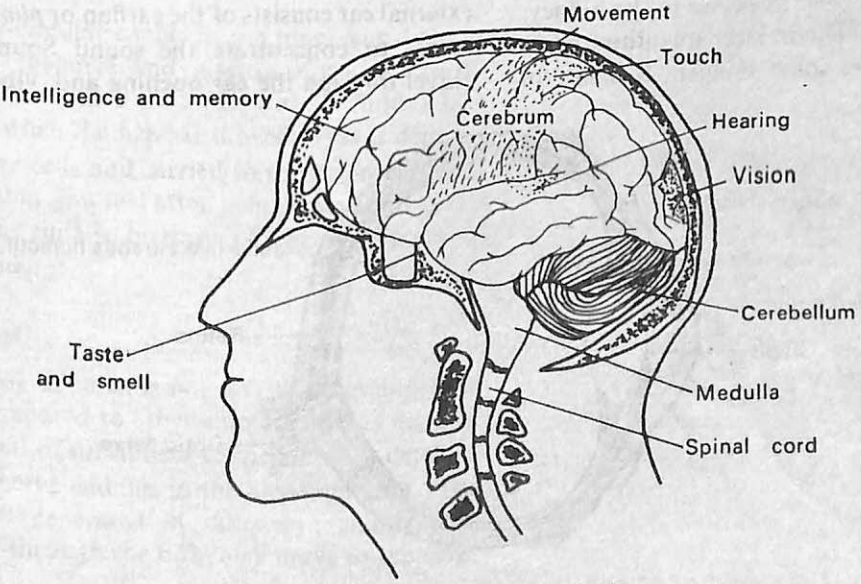


FIG. 19.10 The human brain

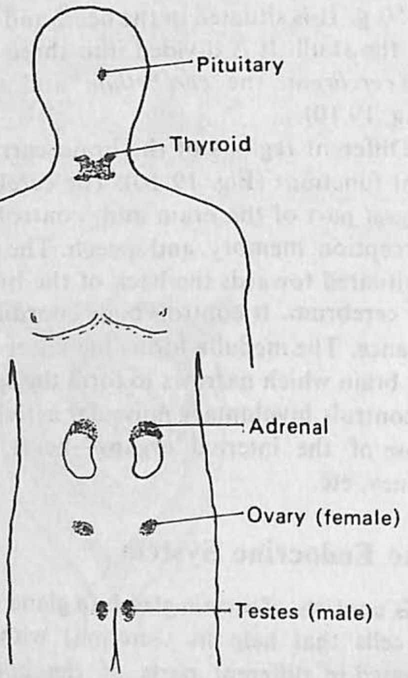


FIG. 19.11 The endocrine system

growth in children. Deficiency of the hormones can result in dwarfism.

The *thyroid gland* is situated in the neck. The hormone secreted by it affects general metabolic rate.

The two *adrenal glands* lie close to the kidney. They secrete *adrenaline* in large quantities when the body encounters some danger. It helps in making a lot of energy available for action. The body can then either fight the danger or else run away from it. This is known as the *fight or flight* reaction.

The *sex glands* are the *testis* in male and *ovary* in female. You have already read about them.

The Sensory System

The sensory system consists of the eyes, ears, skin, tongue and nose. They help us to see, hear, feel, taste and smell respectively and form our points of contact with the external world.

The Eyes

These (Fig. 19.12) are situated in the sockets of the skull. They admit rays of light coming from external bodies through the *pupil*. The *eye lens* forms an image of the external bodies on the light sensitive tissue known as *retina*. The sensory impulses are received by minute nerves that join up to the optic nerve and send the sensation to the cerebrum. Fig. 19.12 shows the important parts of the eye.

The Ears

The ear can be divided into three parts—the external, middle and inner ear (Fig. 19.13). The external ear consists of the earflap or *pinna* which serves to concentrate the sound. Sound waves travel through the ear opening and vibrate the

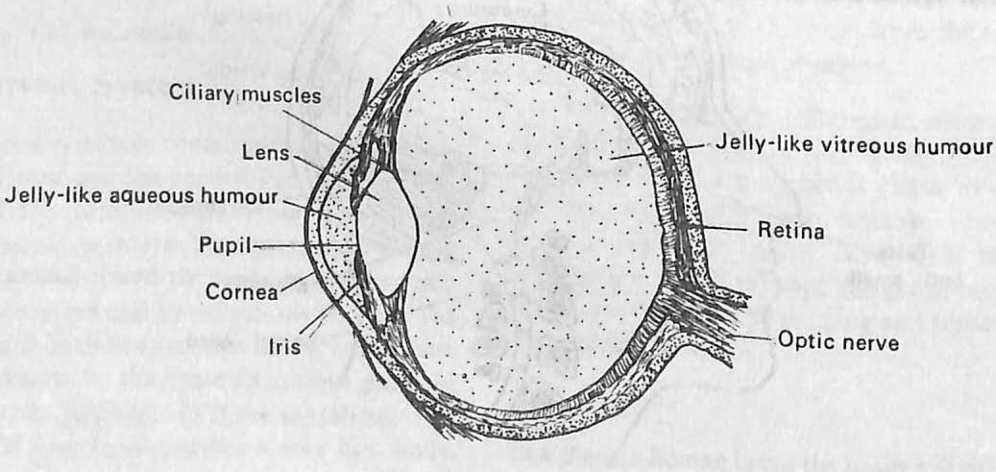


FIG. 19.12 The human eye

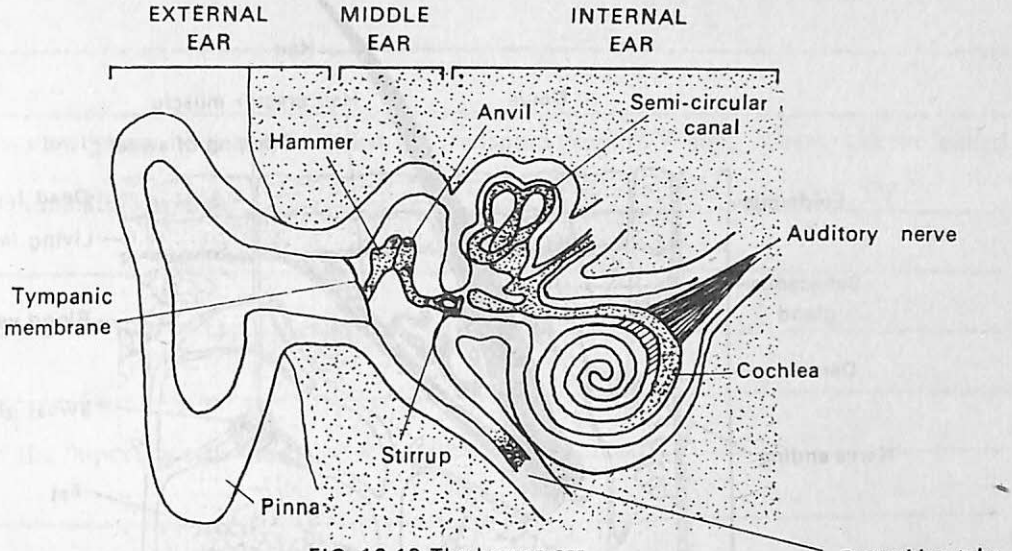


FIG. 19.13 The human ear

eardrum or *tympanic membrane*. The middle ear consists of three small moveable bones called *stirrup*, *anvil* and *hammer*. These help to transmit the sound to the inner ear. The inner ear contains three *semi-circular canals* and a coiled structure full of fluid called the *cochlea*. When the sound vibrations are received in the inner ear, the fluid in the cochlea starts vibrating.

These vibrations are detected by nerve cells in the cochlea and transmitted to the brain through the auditory nerve.

Semi-circular canals in the inner ear help to provide balance and a sense of position to the body. The canals are filled with a fluid which moves when the head is moved. This is detected by nerve cells and carried to the brain. The dizziness that you feel after going round and round for some time is because of the movement of this fluid.

The Nose

The sense of smell is not so well developed in man compared to other animals such as the dog. The smell of substances carried in air is detected by the nerve endings in the nasal passage. The impulses generated in the nerve endings are carried through the *olfactory* nerve to the cerebrum.

The Tongue

Taste and smell are connected. To some extent taste depends on smell. The four basic tastes are salt, sweet, bitter and sour. These are detected by the nerve endings, called *taste buds* in the tongue. Taste buds are distributed over the front, sides and back of the tongue (Fig. 19.14).

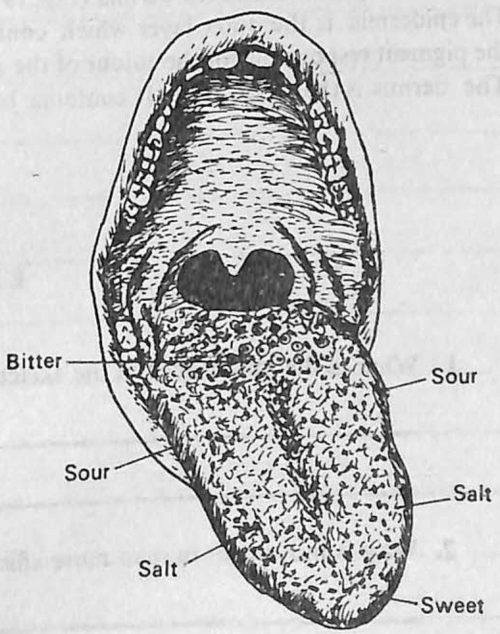


FIG. 19.14 Taste buds in the human tongue

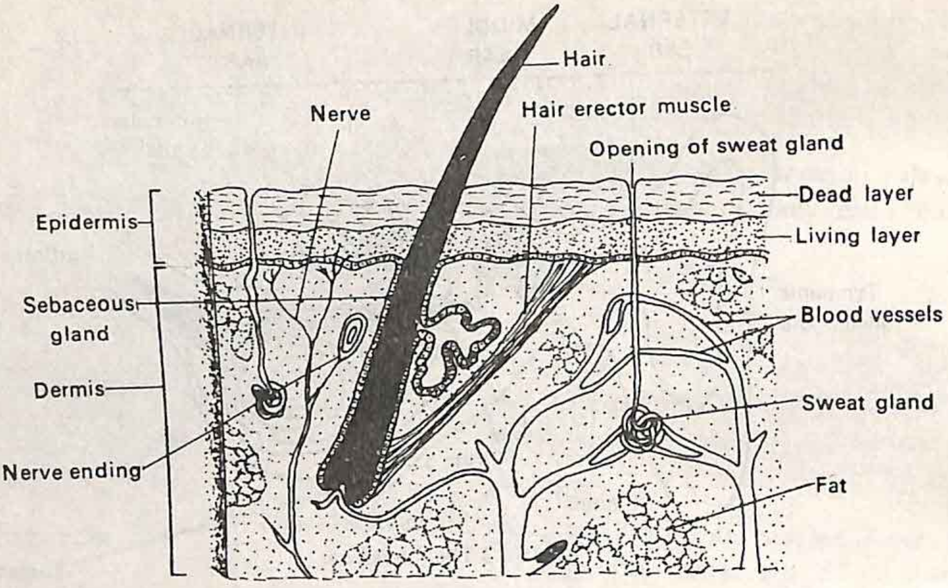


FIG. 19.15 The skin

The Skin

The sensations of touch, pressure, pain, warmth and cold are detected by the sensory nerve endings in the skin.

The skin can be broadly divided into two layers—the *epidermis* and the *dermis* (Fig. 19.15). The epidermis is the outer layer which contains the pigment responsible for the colour of the skin. The dermis is the inner layer. It contains blood vessels, nerve endings, oil producing glands, sweat glands and the hair roots.

The skin protects the body against bacteria and virus. It also controls the water loss and thus regulates the body temperature. Another function of the skin is to protect the body against friction and other external pressures. The skin of portions such as the soles of the feet which have to face constant pressures and friction, is therefore very tough.

EXERCISES

1. What is the importance of the skeleton system in our body? ____________________

2. Why is movement in man more efficient than in an earthworm? ____________________

3. Which system in our bodv can be called the transport system? Which system can be called the communication system?

4. What is the function of capillaries in the body?

5. What is the importance of the excretory system?

6. What is fertilization? How does the fertilized egg get nutrition for growth?

7. What are hormones? Name any four.

8. What is 'fight or flight' reaction?

9. What are the functions of the skin?

10. Give the functions of the following.

(i) Vertebral column

(ii) Ligaments

(iii) WBC

(iv) Plasma

(v) Artery

(vi) Vein

(vii) Nephron

(viii) Ovary

(ix) Testes

(x) Zygote

(xi) Umbilical cord

(xii) Motor and sensory nerves

(xiii) Spinal cord ________________________________

(xiv) Neuron ________________________________

(xv) Cerebrum ________________________________

(xvi) Thyroid gland ________________________________

(xvii) Retina ________________________________

(xviii) Cochlea ________________________________

(xix) Olfactory nerve ________________________________

(xx) Taste buds ________________________________

(xxi) Dermis ________________________________

(xxii) Pinna ________________________________

(xxiii) Pulmonary vein ________________________________

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Man and His Environment

We have studied by now the life processes of plants and animals. We realise that living organisms are dependent on each other. The cow eats plants for its survival. The plant needs nourishment from the soil which is provided by nitrogenous matter excreted by animals or by the dead bodies of other plants and animals. Thus any living organism, whether plant or animal, is affected by other plants and animals around it, as well as by physical factors such as temperature, humidity or rainfall. All such factors that affect the organism make up the *environment* of that organism. The branch of biology concerned with plant and animal relationships with their environment is called *ecology*. Plants, animals and micro-organisms, together with the environment in which they live, make up the interdependent unit, called the *ecosystem*. An ecosystem may be in the ocean, in a forest, in a mountain or in a desert. The entire zone of land, air and water inhabited by living organisms is called the *biosphere*.

Like any other organism, man is also affected by his environment. However, with increasing scientific knowledge, man is able to modify the environment to suit his immediate needs much more than any other organism. This enables man to improve the quality of his life. He can now cure many diseases and can get better yield from his crops. However, man's efforts to change nature have also had several harmful results. Man has devastated forests for wood and for getting more agricultural land, only to find his water supply diminishing and his supply of soil eroded away. He has polluted the rivers with chemicals from factories, thereby making the water unsuitable for his needs.

All these devastating effects of man's effort to control nature have occurred because he has upset the balanced interrelationship of the organisms that make up the environment. Man has failed to realise that any new factor upsets the balance of the ecosystem as a whole. An example is the widespread use of insecticides in the U.S.A. during 1950s and 1960s. The immediate effect was a reduction in pest population and an increase in the yield of crops. However, the insecticides also poisoned and killed birds who feed on insects. As a result, the next generation of pests multiplied even faster in the absence of their natural enemies, and damage to crops was much more.

Pollution

One of the major dangers facing human and other forms of life today is the defouling or *pollution* of the environment by man, as a result of increasing industrialization. Pollution is an undesirable change in the physical, chemical or biological characteristics of air, water and land that may endanger human and other life by depleting natural resources. Chemical waste pollutes land and water, gases from factories and automobiles pollute the air, and radioactive matter from atomic explosions pollutes land, water and air. The important pollutants and their effects are as follows.

Air Pollution

Air pollution poses serious problems in congested, industrialized cities with heavy vehicular traffic. When inhaled with air, these pollutants cause many respiratory disorders such as congestion in respiratory tracts and lungs, and allergies. Some of the major air pollutants are as follows.

(a) *Carbon monoxide:* Common sources of carbon monoxide are cigarette smoke, motor vehicles, industrial plants and domestic non-electrical heating appliances. Carbon monoxide impairs oxygen absorption by the blood. It can cause death on prolonged exposure.

(b) *Sulphur dioxide:* Sulphur dioxide is produced during burning of fossil fuels such as coal. It is released in large quantities in power-generating plants and other industries using coal.

(c) *Particulate matter* (consisting of small particles in the air) such as smoke or fly ash is given off during burning of fossil fuels such as coal. They seriously affect the respiratory system and also reduce visibility.

Water Pollution

Polluted water contains some foreign matter that degrades its quality and makes it less suitable for drinking, domestic, agricultural, recreactional and other purposes. The major pollutants of water are as follows.

(i) *Sewage:* Sewage and industrial wastes from factories which are discharged into rivers, constitute the major source of water pollution. A recent study in Delhi has revealed that the Jamuna water has been polluted to such an extent by sewage and industrial waste that it is unfit for drinking. Discharge of sewage into rivers causes spread of bacteria, causing waterborne diseases such as typhoid, dysentry, cholera, etc. It also introduces in the water toxic substances harmful to the body.

It also helps the growth of aquatic micro and macro-organisms, which use up oxygen dissolved in water. When they die, their decomposition consumes more oxygen. This depletion of oxygen in water affects aquatic life.

(ii) In villages, bathing and washing is very often done near ponds or wells. This causes dirty water to flow back into the pond or well. If this water is used for drinking purposes, it can lead to waterborne diseases.

Noise Pollution

If your house is very near a main road you wil know how irritating the constant rumbling oi traffic and blaring of horns is. This *noise pollution*, or increase of the noise in the environment can lead to high blood pressure, hearing problems leading to deafness, loss of sleep, headache, etc.

Vehicles, machines, trains, aeroplanes, high pitched music are all sources of noise pollution.

EXERCISES

1. Define the following.

Ecology ____

Environment

Ecosystem

Biosphere

Pollution

2. Scientific progress is beneficial as well as harmful. In what way does it harm us?

3. What is pollution? Why are we so concerned about pollution today?

4. What problems does air pollution cause?

5. Name two important air pollutants and their sources.

6. What is the major cause of water pollution? How does water pollution affect us? ________

7. What do you mean by noise pollution? What are its effects on the human body?________

8. Name some waterborne diseases caused by water pollution.________

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